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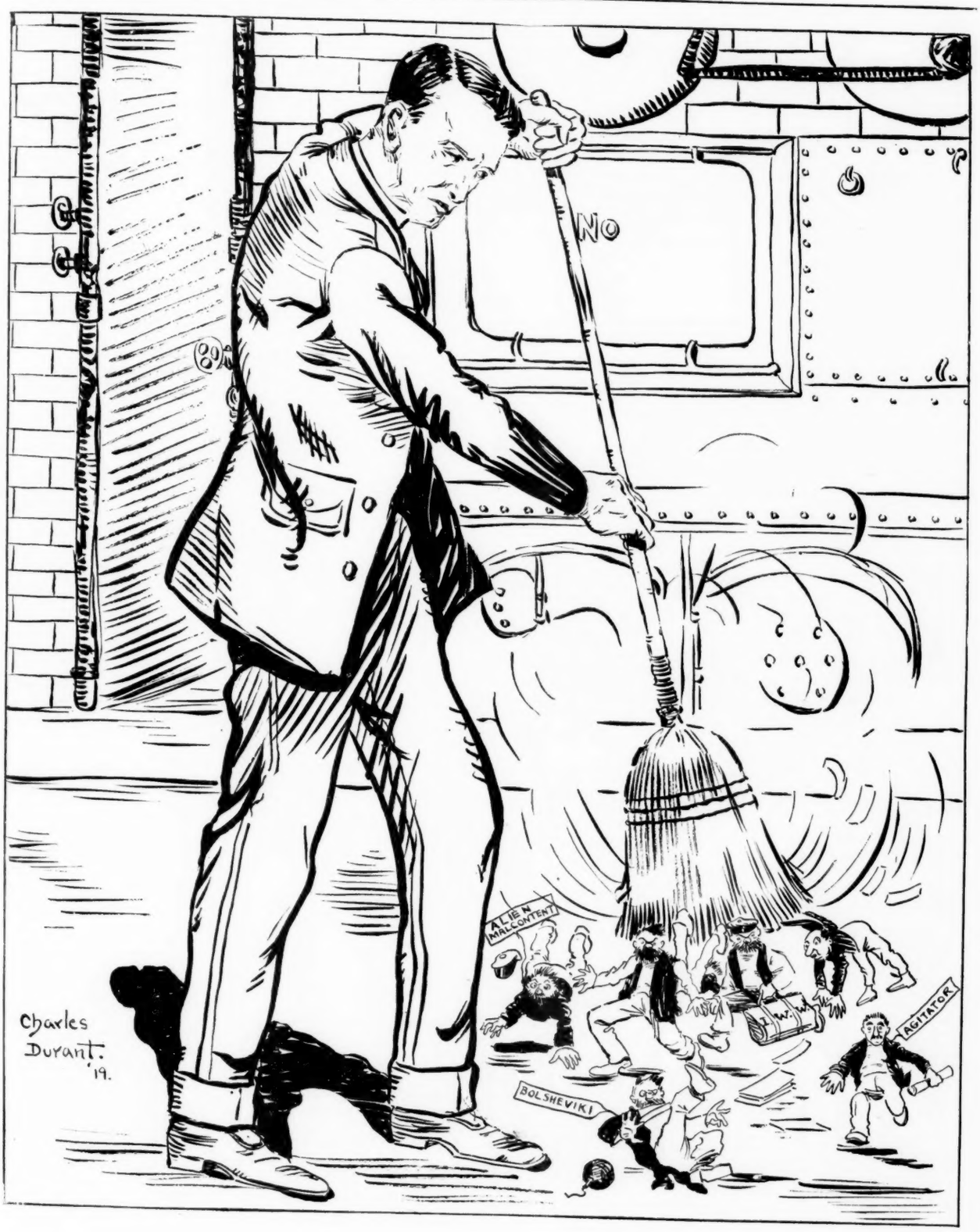


Induction Motors Driving Centrifugal Pumps

By FRASER JEFFREY
Electrical Engineer, Allis-Chalmers Manufacturing Company

THE induction type of polyphase motor is especially well adapted for direct connection to centrifugal pumps not only on account of its simplicity of application and operation, but also by reason of the wide range of output and speed that is obtainable. In the accompanying table are shown the synchronous speeds that may be obtained. The full-load speeds are from 1.5 to 5 per cent. less, depending on the size and type of motor used. Lower speeds than shown are possible, but may be considered as more or less special and therefore have not been listed. There are two distinct forms of induction motor, the squirrel-cage and the slip-ring types, each having certain definite applications of its own and the applicability of one or the other being determined more or less by local conditions and the exact requirements that are to be met. The squirrel-cage motor consists of a primary member, or stationary stator, which carries the coils energized by the source of supply, and a secondary, or rotating member, called the rotor, which carries a number of current conducting bars short-circuited on themselves by means of end rings which are located at either end of the core, as shown by Fig. 2.

With the squirrel-cage motor there is a definite limit to the static or starting torque it will develop. A commercial machine of this type is designed to exert a starting torque, if it were thrown directly on the line, which varies with the number of poles and the speed, in amounts as shown in the table. Except in the case of small machines the squirrel-cage motor cannot be started by connecting it directly to the line. As with the direct-current motor the rush of current is so great as to cause undesirable fluctuations in voltage, excessive demands of current at very low power factor on the generating equipment and dangerous shocks to the motor, pump and pump lines themselves. The average squirrel-cage machine, if thrown directly across the line, will draw a current of from 4½ to 8 times normal, depending upon the inherent characteristics of the particular machine. In starting the general method is to apply a reduced voltage to the primary member and then, when the rotor is up to speed, to throw over to full line voltage. By doing this, the shocks and line fluctuations are greatly minimized, but the starting torque is also reduced in the ratio of the squares of the applied voltage to the normal voltage; that is, if a voltage of one-half normal is first applied, the starting torque will be one-fourth what it would be with full voltage. The general practice is to supply all motors over 5-hp. in size with some form of starting compensator, but for 5-hp. and less it is satisfactory to throw them directly on the line. Fig. 3 shows a typical wiring diagram such as is used in connection with the larger type (200-hp. and above) of squirrel-cage motor. The same thing is shown for the smaller sizes in Fig. 6, while in Fig. 4 is illustrated the form of wiring that is generally in use for motors of 5-hp. and less. While the control for the large motors, shown in Fig. 3, requires a panel, that for Fig. 6 can be mounted conveniently on pipe framework, as in Fig. 7, making a simple and convenient outfit to install. For special cases and where warranted, an automatic magnetic type of control may be used. Such an installation is shown in Fig. 5. An installation of 400-hp. 1200 r.p.m. pumping units with control apparatus similar to that in Fig. 3 is shown in Fig. 1.

SYNCHRONOUS SPEEDS OF INDUCTION MOTORS

No. of Poles	Synchronous Speed — 60 Cycles	50 Cycles	40 Cycles	25 Cycles	Starting Torque in Per Cent. of Full-Load Torque for Full Voltage, Squirrel-Cage Motors Only
2	....	....	....	1500	150
4	1800	1500	1200	750	150
6	1200	1000	800	375	135
8	900	750	600	300	125
10	720	600	480	250	120
12	600	500	400	....	115
14	514	428	343	....	110
16	450	375	300	....	105
18	400	333	267	....	100
20	360	300	240	....	100

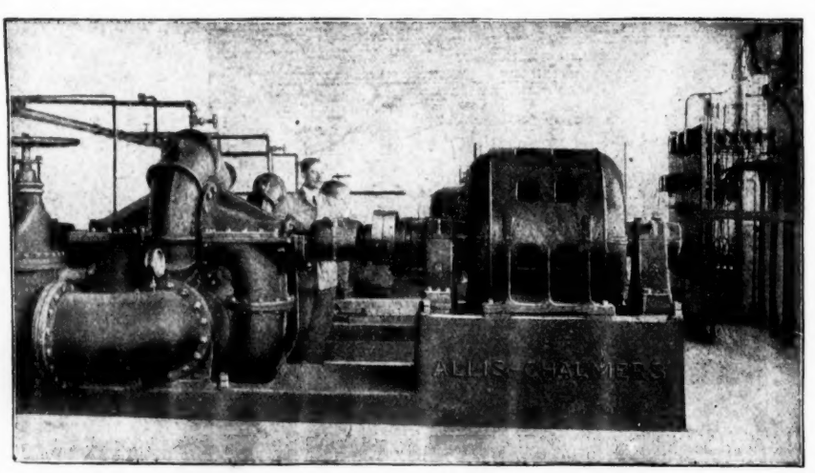


FIG. 1. INDUCTION MOTORS IN IRRIGATION PUMPING STATION

The slip-ring motor has a stator which is the same as for the squirrel-cage machine. The secondary member differs, however, in that it carries a complete polyphase winding, similar to the primary member, the terminals of the rotor being connected to three slip rings as in Fig. 8. By inserting an external variable

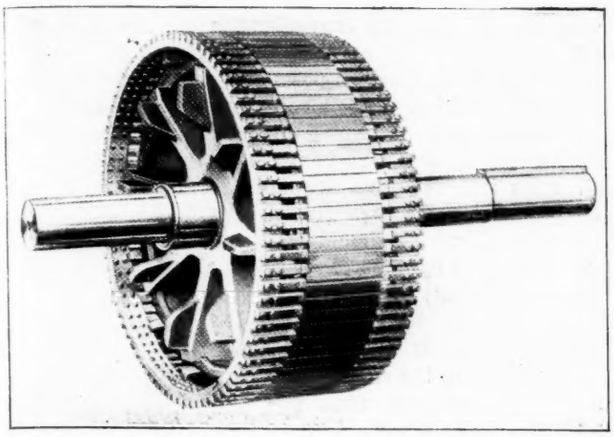


FIG. 2. SQUIRREL-CAGE ROTOR

resistance in the circuit of the rotor winding, the speed for any given load can be varied to meet any required condition; the current taken from the line at starting can be controlled within certain definite limits for any given torque up to the maximum the motor can deliver, and the power factor at starting remains the same as when the motor is running for any given load condition, which is a desirable feature.

Unlike the squirrel-cage motor, the starting torque can be varied and the primary current controlled over wide ranges. The usual method of starting is by inserting such an amount of resistance in the rotor as to obtain full-load to 1½ times full-load torque, with full-load to 1½ times full-load current, the power factor of the circuit remaining the same as if the motor were actually running under these loads. By gradually cutting out the secondary resistance, the motor is brought up to speed, the last notch of the controller short-circuiting the rotor winding. By inserting resistance, the

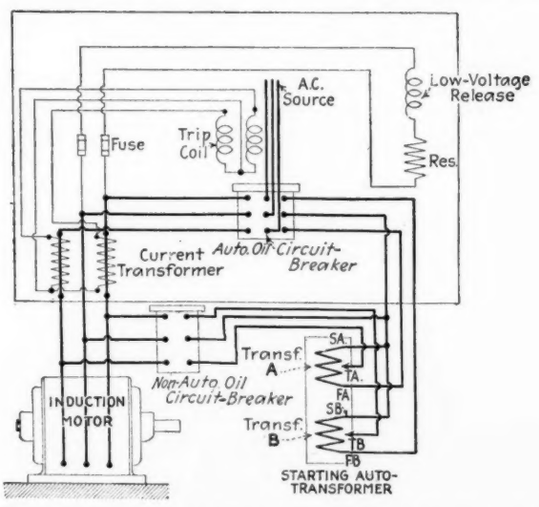


FIG. 3. CONTROL CONNECTIONS FOR LARGE SQUIRREL-CAGE MOTOR

speed of the motor may be varied if the control is constructed for such service. Figs. 10 and 11 show a wiring diagram and panel respectively, used with smaller type of wound-rotor induction motors. In the larger sizes the general practice is to use either a drum type or mutiple-switch type of starter, and if the installation warrants, the full magnetic type of control or the automatic type of liquid control is often used.

For centrifugal-pump work the squirrel-cage motor is well suited on account of the simplicity of not only the motor itself, but also the control. Usually, the first cost is less than that of the slip-ring type of motor, but there are local conditions that determine more or less which type of machine should be used. The squirrel-cage motor is inherently one of low starting torque with relatively large starting currents, and when used in connection with a pump, there should be some means provided, such as a valve in the discharge line, for unloading purposes during the starting period. If such an unloading device is not supplied, the condition may arise where the motor may not have the necessary torque to start up the pump, and even if it has, the shock to the motor, pump and packing system is most severe when the motor is thrown from the starting to the running position. Especially is this true if, during the starting period, a large head of water has been built up, and if such is the case the shock of throwing over has been known to cause a water-hammer severe enough to break the piping. With the unloading valve, however, these difficulties are overcome, and this type of motor is extensively used in many different kinds of commercial and specialized industries. In addition, the squirrel-cage motor is apt to cause line fluctuations that may be objectionable, and in certain cases the capacity of the generators at the source of supply may be such as to warrant the use of the slip-ring type of machine. Also if a certain amount of speed variation is desired, this can be obtained only by the use of the phase-wound motor with resistance connected in series with the rotor. The resistance for this purpose must be designed to carry full-load rotor current continuously.

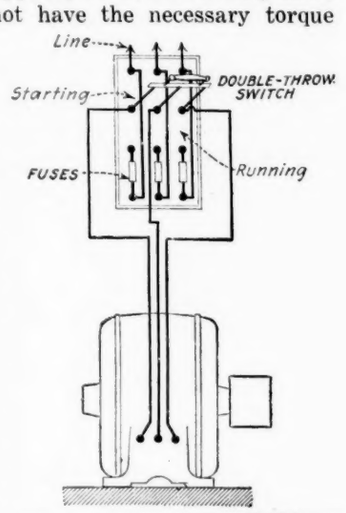


FIG. 4. SQUIRREL-CAGE MOTOR CONNECTED DIRECTLY TO LINE

In the larger sizes of units the slip-ring motor is preferable on account of its ability to start up smoothly against a head or heavy load, drawing a minimum cur-

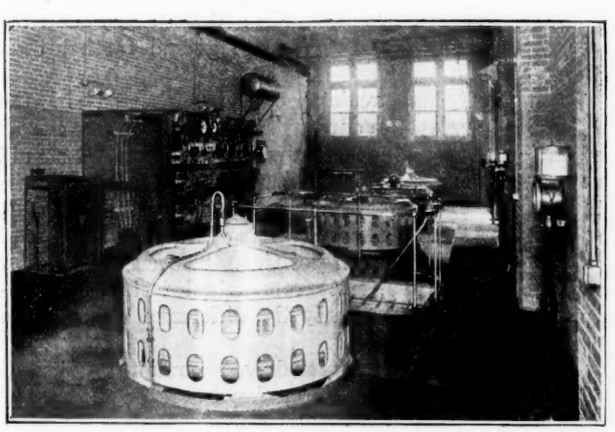


FIG. 5. VERTICAL SQUIRREL-CAGE MOTORS UNDER AUTOMATIC CONTROL

rent from the line and thus causing small line fluctuations and shocks to the apparatus itself.

In Fig. 9 is illustrated the different current, speed and torque characteristics of the squirrel cage and the slip-ring types of motor. Curves A_c and A_T are the current and speed-torque curves respectively of a squirrel-cage motor, if thrown directly across the line; curves B_c and B_T are the same thing when the motor is started under voltage reduced to 50 per cent. of normal. Curves C_c and C_T are from the slip-ring type of motor with the secondary resistance adjusted to give maximum starting torque, and curves D_c and D_T the same with the resistance adjusted to give full-load torque at starting, any intermediate points being taken care of by the controller.

A close study of these curves will show the chief points of difference between the two different types of motor. It should be specially noticed that the limit of

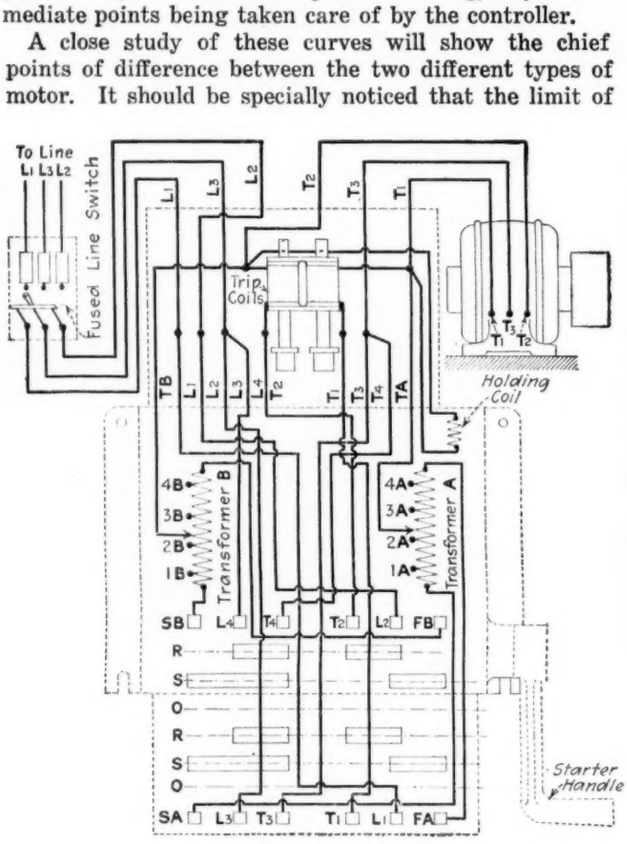


FIG. 6. CONTROL CONNECTIONS FOR MEDIUM-SIZED SQUIRREL-CAGE MOTORS

current in the slip-ring motor is dependent upon the amount of secondary resistance, and for this reason the current curves C_c and D_c do not extend farther than shown.

If no external resistance were inserted in the secondary circuit, the current curve would follow closely or on top of that for the squirrel-cage motor. It should be borne in mind, however, that a slip-ring type of motor without external resistance in its secondary circuit will produce practically no starting torque and will tend to lock in the stand-still position. The curves in Fig. 9 have been drawn, not from actual tests, but relatively, to show more clearly the difference between the two kinds of motor.

When installing a motor-driven pumping unit, all wiring must be done in accordance with the rules of the Underwriters' Inspection Bureau having jurisdiction in the particular district in which the apparatus is located. Potential starters, speed controllers, panels, etc., should be set up convenient to the motor, so that not only will all connecting leads from the control to the motor be as short as possible, but the motor can be seen when the operating mechanism is being used.

Assuming that all wiring connections have been carefully checked, it is well to see before starting that the oil wells and bearings are free from dust and grit; that the oil rings turn freely; that the oil, which should be a good grade of dynamo oil, is at the proper level; that the alignment is such that the unit turns over freely and without binding, and in the case of slip-ring type motors that the brushes on the slip rings make good contact to the full area of the brush. When necessary to true up the brushes, a fine sandpaper may be used and the sanding done relative to the direction of rotation of the motor. In cases where no interlock is used between the secondary starter of a slip-ring motor and the primary oil switch, it is most important to make certain that the handle of the rotor starting resistance is in the starting position before throwing in the primary switch. If this is not done, the motor will short-circuit the line and considerable damage may occur.

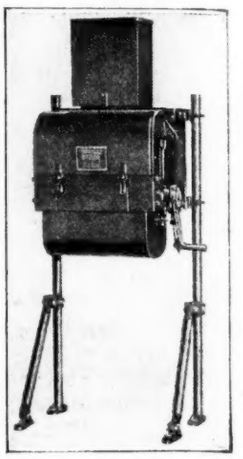


FIG. 7. STARTER FOR SQUIRREL-CAGE MOTOR

When starting for the first time, it is advisable to run the unit without load in order to verify the points brought out in the foregoing. If the motor runs in the wrong direction, the rotation may be reversed by changing the primary leads; for a three-phase motor, interchange any two connections of any phase; for a two-phase motor, interchange any two connections of one phase only.

In starting the squirrel-cage motor provided with a potential starter, the handle is moved from the "off" position to the "starting" position, and after the motor has come up to speed, it is thrown to the "running" position. The handle should be moved quickly when passing from one position to the next, but should be allowed to rest for a short interval on the starting position, or in each position if the starter has more than one starting point, in order to give the motor time to come up to

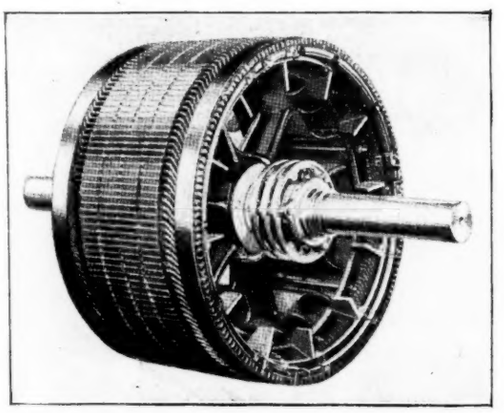


FIG. 8. ROTOR OF SLIP-RING INDUCTION MOTOR

speed. In no case must the starter be held on the starting position for more than one minute, otherwise the starting transformers may be injured. If the motor does not start readily, the transformer taps may be changed to give a higher applied voltage; on the other

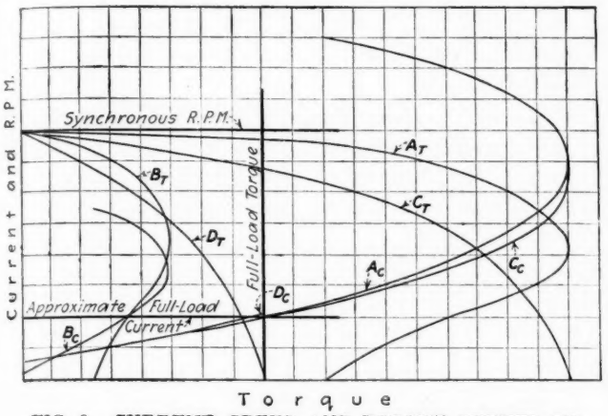


FIG. 9. CURRENT, SPEED AND TORQUE CURVES OF INDUCTION MOTORS

hand, if the motor starts with an excessive jerk, the applied voltage should be reduced.

In starting the slip-ring motor the primary switch is first closed, after which the handle of the starter is moved step by step, allowing the contacts to rest a few seconds on each segment, the time depending a great deal on the nature of the load, until the running point is reached, where all resistance is cut out. On controllers for starting duty only, care must be taken not to leave the handle on any of the starting points, or else the resistance may become overheated, with consequent troubles developing. Under ordinary conditions it should not take more than 20 sec. to bring either of the two types of motor up to speed, provided the pump is unloaded when starting with the squirrel-cage type of machine.

On account of their inherent characteristics induction motors are made with relatively small clearances

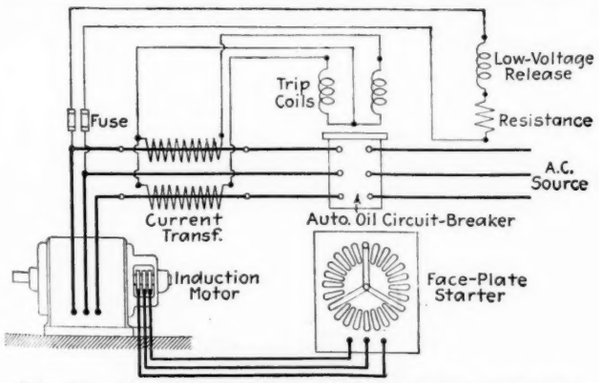


FIG. 10. CONTROL WIRING DIAGRAM FOR SLIP-RING TYPE INDUCTION MOTOR

between the rotor and the stator. The greater the air gap is made the lower the power factor becomes, so that the clearances are made such that from an electrical standpoint the power factor remains high, while from a mechanical standpoint the operation is reliable. This clearance, called "air gap," is usually measured in thousandths of an inch, and occasional inspection of bearings and air gap is advisable to make sure that the shaft has not more than the usual allowance of clearance in the bearings and that the rotor is central with respect to the stator.

A temperature rise of from 40 to 50 deg. C., or 70 to 90 deg. F., above the surrounding air is the usual allowance on all the windings and laminations of induction motors when operating at normal load, and there is no occasion for alarm if any part of the motor feels hot to the touch. All parts become warm after a time and a motor may feel hot and still be well below the allowable temperature. At the same time any abnormal temperature rise should be investigated and the cause determined with as little delay as possible. To obtain

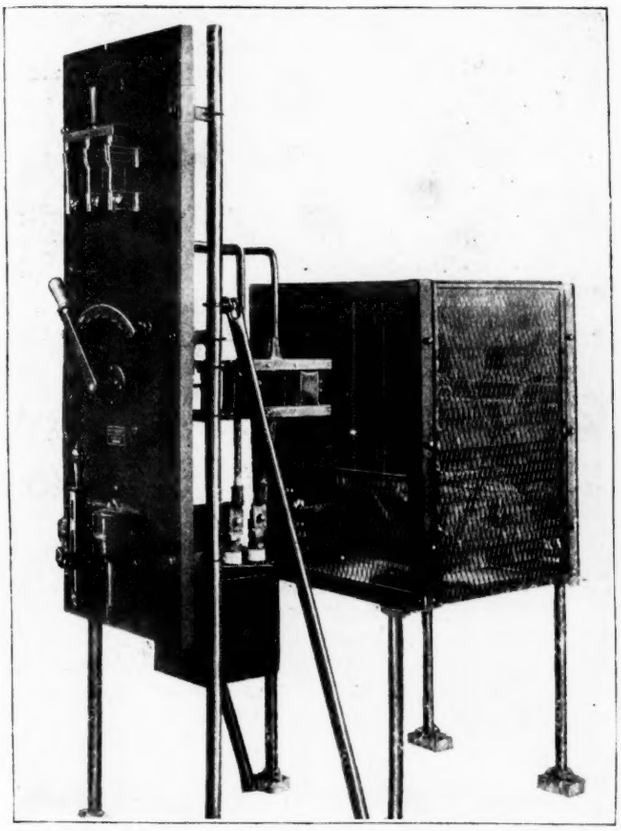


FIG. 11. CONTROL FOR LARGE SLIP-RING TYPE INDUCTION MOTOR

full output and satisfactory service from an induction motor, it is essential that the line voltage and frequency be not allowed to drop below the rated values for which the motor is designed.

Shanghai, China, is rapidly developing into a progressive industrial and manufacturing center. Practically all textile and flour mills established during the last five years are run by electricity purchased from the municipality, and even some of the older mills are installing motors.

Interesting and important experiments are being carried on in England in connection with the utilization of the airplane engine for ordinary commercial purposes. By making an alteration in the carburetor it is possible to run the engines on coal gas, and they have been connected to dynamos with very good results. While second-hand airplane engines have a limited market, it is believed that as stationary power units they will prove a useful innovation.

Making a Packing-House Refrigerating Plant Carry Its Load

By J. C. MORAN

Unable to put more coil surface in the coolers, brine circulation over the direct expansion coils was provided and the temperatures lowered and maintained.

WHILE overhauling a small ice plant in the South, I received a visit from the troubled owner of a small packing plant which could not do the work required of it. It was a case of either building more coolers and buying more machinery or trying to improve what he already had. Everything was working up to the limit and still the cooler temperatures were ten to fifteen degrees too high. A considerable increase in output was expected during the coming summer.

The system was direct expansion throughout. A large hot-beef cooler and a storage cooler were on the second floor. On the floor below were the wholesale market and two small freezers. The coils were hung on the walls in all the rooms. All piping was covered with

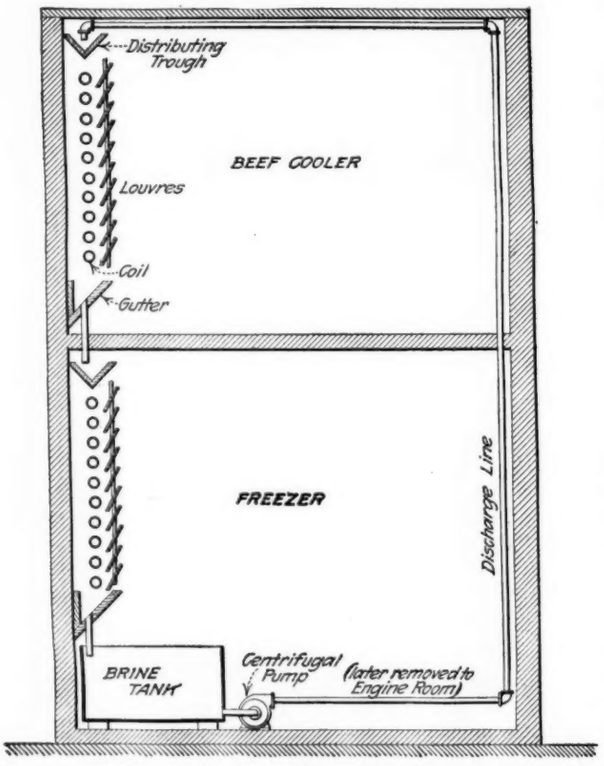


FIG. 1. SHOWING COILS AND DISTRIBUTING TROUGHS

several inches of frost, as usual. This we soon got rid of by installing a hot gas connection to the liquid line by which we could put hot gas from the discharge line into the coils at regular times. The hot-beef cooler and storage cooler were still at too high a temperature mainly because there was not enough cooling-coil surface.

The freezers and the wholesale market had an abundance of pipe, and here there was no trouble to maintain the temperatures after the coils were cleaned. To make use of all the rails on which the beeves were hung, it was impossible to add more coils because the meat would then be hanging against the coils and freeze to them. If we did not use the rails next to the coils,

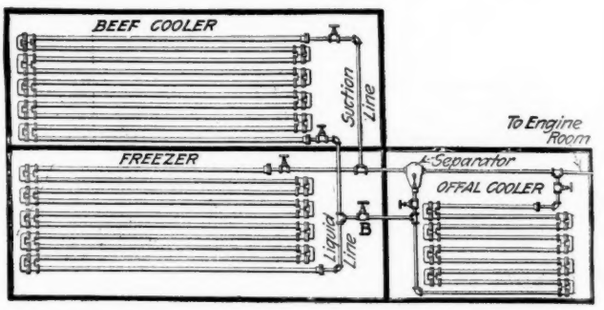


FIG. 2. CONNECTIONS TO COOLER AND FREEZING COILS

it would mean a reduction of capacity of about 50 head per day, which again could not be tolerated.

I did some "tall" thinking on this problem for a couple of days until I remembered reading that one fellow had solved a somewhat similar problem by providing brine circulation over the coils in the rooms where the piping was inadequate. I decided that this was worth trying. We bought a few galvanized distributing troughs such as are used on atmospheric condensers, and these were hung above the coils on one side of the room. Another set was hung above the coils on one side of the room in one of the freezers down below.

Trying the Experiment

A small centrifugal pump was borrowed from the ice plant and installed in the freezer in connection with a small tank into which the brine collected after it left the coils. Everything was now set for the experiment, pipes having been connected from a trough under the coils in the freezer and the hot-beef room, the pipe from the trough in the freezer leading to the collecting tank to which the pump was connected, the pipe from the coils in the hot-beef room were led down through the floor to the distributing trough above the freezer coil. Canvas strips were hung in front of the coils to prevent the brine spattering out on the floor. A temporary pipe connection was run from the discharge side of the pump to the distributing trough above the one coil in the hot-beef cooler. By this arrangement the brine would first pass over the coil in the hot-beef room, collect in the trough under the coil and run down through the pipe connection to the freezer coil below and over this into the trough under this coil, from which it was led to the collecting tank and again started back over the same route.

We procured some calcium and prepared sufficient brine to fill the collecting tank and started the pump. After some trouble adjusting the distributing valves above the troughs, the arrangement worked well. The

suction pressure increased considerably, the freezer temperature even went down a degree or two and the hot-beef room temperature dropped several degrees during the afternoon while the cooler was filling, which was unheard of before.

Details of the Final Construction

Both the owners and myself were so satisfied with the experiment that we decided to make it permanent. Fig. 1 illustrates the final construction. A small motor-driven centrifugal pump was installed in the engine room and connected to a collecting and storage tank in the freezer, the discharge from the pump led through several branches to troughs above each of the coils in the hot-beef cooler and storage room. The brine, after circulating over the coils in these coolers, collected in gutters beneath the coils and passed through connecting and distributing pipes to the freezer coils below. After passing over these it returned to the storage and collecting tank.

To prevent the brine spattering over the floor and also to aid in the best possible manner the circulation of the air, wooden louvers, as indicated in the sketch, were placed close to the coils. The sketch illustrates the arrangement for one side of the room only. In the finished job all the coils were arranged the same way.

To give more space in the beef coolers, a small offal cooler had been built next to one of the freezers. The coils had already been installed in this, but had not been connected to the suction or liquid lines. Here I made use of another "wrinkle" that I had noticed while on a visit to a small cold-storage plant.

Steam Separator Installed

A large steam separator was installed in the suction line, as shown in Fig. 2. The drain outlet was connected to the bottom of the offal cooler coil, as shown, and the other end to the suction in the regular way. A common stop valve was placed in the pipe from the separator, as indicated. A connection to the liquid line was also made and an expansion valve installed at *B*, through which liquid could be fed in the regular manner if desired.

The purpose of this construction was to flood the rest of the coils, particularly in the beef rooms where the coils were too small, and thus work them to their maximum capacity, as in a flooded system. The separator in the suction line would separate out all of the liquid carried back in the suction gas, and this would drain down into the coil in the offal cooler. It then became a simple matter of flooding one or more coils sufficiently to supply enough excess liquid to keep the offal cooler working at the right temperature.

Changes Proved Satisfactory

When completed, the plant worked very well. The brine circulation over the coils kept them clean and insured maximum heat-absorbing capacity. The brine circulation over the coils improved the air circulation in the coolers and eliminated a large amount of the dampness in the beef coolers. In case the beef coolers were heavily loaded, we circulated the maximum amount of brine, which threw a large portion of the work on the freezer coils, which had abundant capacity. In this manner we could draw on the heavy freezer coils for reserve capacity for the beef coolers, and this gave ample capacity for the heaviest loads. At the same time we could rapidly lower the freezer temperatures by cutting down the brine circulation and leaving the freezer coils in their clean condition, working practically on the freezers alone.

The offal cooler connection with the separator in the line was a further improvement. We adjusted the expansion valves on the beef coolers in particular so that they threw considerable liquid back into the suction line, thus insuring that they were working at full capacity. The coils in the wholesale market and the freezers were also adjusted to throw an excess into the line, thus insuring maximum capacity from all the coils as long as the offal-cooler coils were supplied with liquid caught in the separator.

Engineers Pleased with New Arrangement

After the system had been run a few days, the engineers became accustomed to it and liked the arrangement. The expansion valves on all the coils were opened a little at a time until the excess liquid carried back in the suction gas was greater than needed by the offal cooler. The main valve in the liquid line in the engine room was then throttled until the discharge temperature of the machine was high and the frost line carried back to the best operating position on the machine. As long as this condition obtained we knew that all the coils, including the offal cooler, were operating at maximum capacity. In case it became necessary to cut off the offal cooler when the temperatures became low, it was a simple matter to throttle the valve in the line from the separator to the coil, which cut off the feed to it and then further throttle the valve in the liquid line in the engine room to take care of the excess that would not be taken care of by the offal cooler.

Economy and Capacity Increased

The increase in operating economy and capacity was surprising. Where before they had been running with a suction pressure of about zero, beef-cooler temperatures as high as 45 deg. every morning and freezer temperatures of about 25 deg., they were now able to handle the load with a suction pressure of about 20 lb., the beef coolers were down to 33 or 35 deg. every morning and it was a simple matter to hold the freezers at 15 deg., even while they had to help to carry part of the beef-cooler load by cooling the brine that came down from them and was circulated over them again after it had been cooled by passing over the freezer coils and coming in contact with the low temperatures in the freezers. Also, where it had been necessary to run two 50-ton machines as fast as possible all the time, it was not required to run the two machines only a small part of the time.

Mill to Burn Powdered Coal

Powdered coal is to be used throughout for firing boilers and furnaces in the new sheet mill of the Falcon Steel Co. now being erected at Niles, Ohio. The power-plant boilers will be powdered-coal fired, using the Quigley compressed-air system for transporting and burning the coal. The pulverized coal will be transported from the milling plant through standard 4-in. diameter wrought pipes to furnaces and boilers for various distances aggregating approximately 800 ft. and will be switched from the main distribution line to a storage bin in the power house for use as required.

Power-Plant Operation on an Efficient Basis

By PAUL R. DUFFEY

Inefficiencies tending to increase the unit cost, can easily creep into the production of heat, power and light for the average power plant of the railroad terminal or the factory. This article deals principally with the power plant of the railroad terminal.

PECULIAR conditions in railroad-shop work render close supervision of power production very essential to reasonable cost of operation. Usually, the terminal power plant, in addition to furnishing steam for driving the air compressors, engines, feed pumps, etc., must supply steam for the drafting of locomotives, heating buildings, drying sand, thawing coal and furnishing power for the testing of lubricators, injectors and air pumps. The load to be carried is as a rule variable through a wide range, and the plant as usually designed or reinforced to meet the maximum requirements operates at a low efficiency during a greater portion of the time in order to be prepared for emergencies that continually arise.

Lack of Means for Determining Power

The principal difficulties encountered in investigating power-plant losses is the lack of means of determining the power of the various classes actually being generated and consumed. City gas and water companies producing a commodity for sale to the community find it to their interest to install suitable apparatus for measuring their commodity to the consumer, even though the monthly consumption in many cases would not pass the dollar mark. Such companies must know exactly how much it is costing them to operate and produce their commodity for sale in order that they may set an equitable price that will allow them a profit and enable them to compete with other companies. It may be argued that a plant generating power for its own use need not go to the expense of installing meters or other forms of efficiency checks, as the expense of operating the plant must be carried in the overhead charges, and that information as to amounts used or costs are superfluous.

Meters of the proper types are essential to efficient power generation, and their use provides definite knowledge that maximum economy is being obtained. But, whether meters are provided or not—and in the majority of cases they are not—there are a number of items that contribute to inefficient power-plant operation and that may be controlled wholly or in part by systematic supervision. These items, which are common to a large percentage of power plants, but particularly to the railroad terminal plant, may be classified under the following heads: Improper operation of power units; steam, air and water leaks; waste of power delivered, fuel and labor.

Improper Operation of Power Units

One of the most serious problems of the chief engineer is to operate his equipment at maximum efficiency under existing conditions. If the equipment is not adapted to the plant and is only about 50 per cent. of that required, it is up to the chief to get that 50 per cent., though by so doing he is getting the maximum or 100 per cent. If at the other end of the city a similar plant is getting only 25 per cent. out of its 50 per cent. equipment, the result obtained is 50 per cent. quality at the second plant. Therefore, efforts should be directed toward obtaining from the equipment the maximum economy. This cannot be done unless the equipment is kept in the best possible repair. By way of illustration, one will often find the electric-generator engine pounding badly in the main crank bearing and running hot on the outboard bearing. Such a condition lessens the output of the machine and makes the steam consumption excessive. It will hardly develop at one time, but is the result of neglect of a minor repair on the operator's part. The cost of repairs once machinery reaches a dangerous state is as a rule high and must be figured in the final cost of the power delivered.

Checks on Cost of Power

It is not uncommon to see an air compressor running at maximum speed and with an unnecessarily high steam consumption, to keep up the required air pressure against such handicaps as leaky pipe lines, leaky pneumatic hose, tools practically past the state of usefulness and leaky or sticking suction and discharge valves on the compressor itself. Thus, only a fraction of the work being performed by the compressor is useful. Such conditions are inexcusable and can be traced directly to the absence of systematic checks on the cost of power. The compressor or any of its allied equipment which, through lack of attention, does not keep up to the required duty, contributes directly to the inefficiency and waste of every air appliance in the plant, and the poor tool in turn reduces the effort put forth by the workman in its operation.

The popular excuse given for neglect is that an opportunity is not readily to be had for making repairs. To overcome this there should be auxiliary equipment so as to allow for a change over of machines. Even where no such equipment is provided, the chief engineer can usually figure out a way to obtain the necessary time to make repairs. A shutdown of the entire plant for a short period may in the end prove to be a measure of economy.

Steam, Air and Water Line Leaks

One of the greatest sources of excessive power cost is traceable to the loss of generated power without the production of useful work. By this is meant that the long lines of steam, air and water piping which convey water or heat from the station to the departments of the plant frequently waste more through leakage, condensation and friction than they deliver for effective use. Pipe lines should be so arranged as to provide adequate protection from the elements and accessibility for repairs, and in general layout the minimum distance of transmission should be given very careful consideration.

Around the railroad terminal the worst offenders in the matter of pipe lines are the car-repair yards and the engine house, for in many cases the lines must be placed in positions which allow them to be eaten up by

corrosion and rust or broken and otherwise damaged. To provide for adequate protection a detailed study should be made as to insulating the pipe. Inspection of almost any plant will demonstrate the necessity of careful attention to all pipe lines, particularly those under ground. It is not the large leaks which account for having to put on another boiler, compressor or pump; instead, from 25 to 50 per cent. of the power is wasted through lack of supervision of the small things. Leaks in the low-pressure steam or hot-water heating system should be repaired and all traps and returns put in good order, for here alone the saving to be made will pay for many tons of fuel.

Waste of Power Delivered

In passing through the shop one may possibly observe a mechanic drilling holes in a cylinder saddle after it has been placed in position on the locomotive. To do this work he has rigged up a portable pneumatic drill and is having more or less trouble in getting the holes drilled. The air connections to the hose at the main air-supply line and at the drill are leaking badly, the hose has several pinhole leaks, and the drill is so dull that it will not take hold properly. With conditions like this the man doing the work will consume enough time in drilling one hole to have drilled three had conditions been more in his favor. While such waste of delivered power cannot be controlled by the power-plant force, considerable economies may be obtained, by securing the coöperation of the foreman toward reducing such waste to a minimum.

Waste of Fuel

In the average boiler room it will be observed that along the firing aisle in front of the boilers a quantity of coal has dropped off the scoop on its way to the furnace. This coal is soon ground under foot and finds its way to the ash dump. The loss, though only a small one, is readily observable, yet it should not be ignored for other and larger losses that cannot be so readily seen.

Some of the principal losses are due to improper design of the plant equipment, failure to keep the internal and external heating surfaces of the boiler free of scale and soot accumulations and failure to keep baffle walls, furnace walls and other parts of the boiler setting tight and in first-class condition. A part of such losses are inevitable, but in many cases loss may be eliminated by careful supervision supported by accurate checks of the fuel used in proportion to the steam generated. The most modern boiler and stoker equipment and the antiquated hand-fired equipment may be considered on a par unless in each case there are proper means of checking the coal consumed, water evaporated and steam generated. Even with efficient methods of checking installed, unless the management of the plant is systematic there will be much waste, and the benefits to be derived from expensive checking equipment will be lost or of little value.

Firemen Should Be Carefully Instructed

In stationary boiler plants firemen should be carefully instructed as to the best methods of firing and handling the boilers and the supervision should provide against letting the firemen get into a rut. Standards for firing should be set and then followed closely. The fuel used, design of boiler and furnace, draft on boilers, load to be carried and other numerous items must in a large measure govern the standard adopted at any particular plant; and that standard which will readily prove to be the best can be determined only by intelligent trial and advice from the plant engineer.

Another point that has quite a bearing on efficiency is the number of boilers being fired unnecessarily. When three or four boilers are being fired to do the work required of two, the fuel waste is excessive. It will be found economical to keep a close check on all power requirements at different periods of the working day, as this information will enable the boilers on the line to be worked as nearly as possible at their full rated capacity at all times.

Perhaps the greatest waste of labor at the majority of power plants is due to poor management, poor facilities for conveying the fuel to within easy handling distance of the fireman and a lack of proper and efficient methods of ash disposal. Improvement can be made in arranging coal bunkers, without adding to the difficulties usually experienced in unloading cars, to feed the coal directly to the firing floor so that the man with the scoop can shovel it into the furnace without having to take several steps and stoop low at every scoopful fired.

Waste of Labor

It is a good plan to go into the boiler room and watch the men. Every unnecessary step the fireman must take decreases his effort, and even though he takes only one or two extra steps for each scoop of fuel fired, this total waste of energy in a month or a year reaches surprising proportions. The man who is really overworked or doing unnecessary work it not an efficient workman, and many cases of poor firing are due more or less to the fact that lack of proper facilities for performing the work has led men to adopt practices that are wasteful of both fuel and labor. Much more along this line could be said but if the reader will avail himself of a copy of Technical Paper No. 80, "Hand Firing Soft Coal Under Power-Plant Boilers," published by the Bureau of Mines, there is no doubt that much practical information can be obtained, which, if properly applied, will tend to reduce the labor waste around a plant to a minimum.

To keep the business end of the plant on an efficient basis it is necessary to see that suitable records of performance are kept each day and that such records are always available for comparison. The system of records and a check on the plant performance should be such that no item, no matter how small, should escape unnoticed by the engineer in charge of the plant. Such records are available only by using the chief engineer's time in such a manner that he will not waste his labor in doing the things that should have been done in getting out the design for the plant.

Of all the big producing countries, the United States has by far the lowest price per ton for coal production, says the American Chamber of Commerce in London. According to an official statement made upon request by the Board of Trade in Parliament, the comparative prices per ton of coal at the pit head in England and Scotland, America and Europe, average as follows for the latest periods for which particulars are available: Scotland (including six per cent. increase), $6.94; rest of Great Britain, $7.04; U. S. A., June, 1919, $2.68; France, June, 1919, $8.64; Belgium, 1917, $4.32; Spain, 1917, $9.36.

Coal Analyses Made at the Power Plant

By E. D. HUMMEL

A method that obviates the necessity for sending coal to a chemist and gives accurate results promptly. The work can be done by a woman and apparatus costing $300.

COAL analyses are rapidly becoming a necessity in power plants because the best grades of coal go to the stations that have the facts. Moreover, it is now becoming more general practice to consider plant-efficiency records in terms of British thermal units per kilowatt-hour instead of pounds of coal per kilowatt-hour. This latter tendency is advantageous to the operating company and the plant engineer alike, because it gives a fundamental basis for discussing efficiency upon which there can be no misunderstanding. The practice would no doubt have grown faster had it been easier to make proximate analysis of coal. The chief reason for making the coal tests at the plant, however, is that the results can be secured in a few hours after the sample has been received, whereas it may be a matter of days if samples must be sent to a chemist. Getting the data thus promptly permits the engineer to work up operating results based on actual tests of the coal fired instead of results based on analyses of coal handled a week previously which was supposed to be the same. Many plants use the latter method, but there are cases where the results so secured have been found to be misleading.

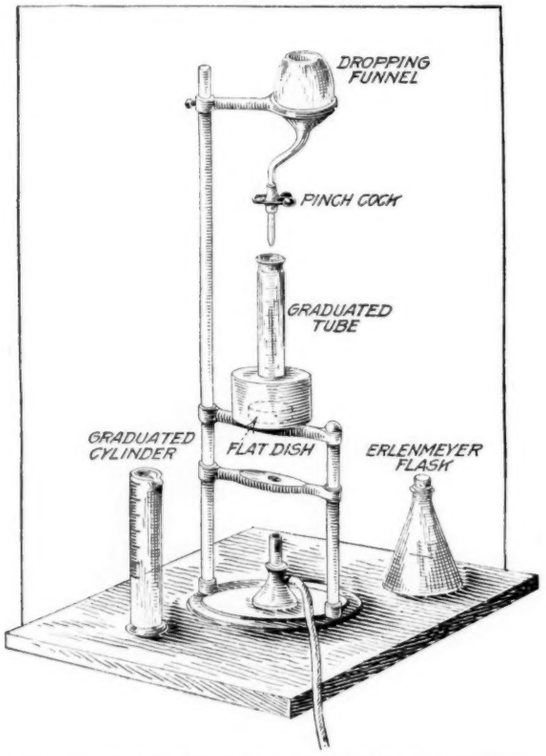


FIG. 1. SOME OF THE APPARATUS REQUIRED

It is usually considered that a chemist is required to determine the number of B.t.u. in a pound of coal. Modern apparatus, however, renders this determination relatively simple, much more so than the average engineer realizes. In fact, the work can be outlined in such a manner that the layman can handle it. The following article describes a simplified method of analysis in power stations to determine the quality of the coal used without sending it to a laboratory.

A manipulator does not have to be a skilled chemist to make a proximate analysis of coal by this method. Any person who is able to calculate, to take temperatures and to weigh, and who possesses a fair degree of common sense, may obtain good results after a little practice. Practice and accuracy in taking readings are the prime factors in getting a final result that may be relied upon.

The following is a tabulation of apparatus required to equip a power station laboratory for the purpose of analyzing coal.

1 Parr standard calorimeter
1 Electric stirring motor—specify whether to be used with 110 or 220 volt d.c., or 110 or 220 volt a.c.
1 Bank of resistance for 110 or 220 volts
1 Hot-air oven
1 Thermometer 0—400 deg. F. for oven
1 Mortar and pestle
1 Balance scale—Becker or equivalent
1 Set of metric weights
1 Desiccator, 6 or 8 in.—Sheiblers or equivalent
1 Bunsen burner
1 Support
4 25-c.c. porcelain glazed crucibles
2 Steel spatulas
1 Crucible tongs
3 2½-in. iron triangles—pipe stem covered
1 Balance scale for coarse weighing—capacity 5 lb.
3 Beakers—200 c.c.
2 Beakers—25 c.c.
1 Parr sulphur photometer

Several pieces of apparatus not mentioned in the list are furnished with the calorimeter and photometer. All the apparatus will cost about $300. The money thus spent will soon be returned, however, if many samples of coal are to be analyzed.

For sampling and preparing the coal, methods described in the Government's Technical Paper No. 133 should be followed. (Fully described and illustrated in *Power* for Apr. 2, 1918, page 476.) The coal sample "as received" should be delivered to the laboratory in a container tightly sealed, having a capacity of two pounds or three pounds.

The first step in analyzing coal is to determine the moisture content. This is done in two operations: First, air drying, then oven drying: To obtain the percentage of moisture in the coal, empty the contents of the container on a square of stiff paper which has been previously counterpoised and weigh it. Allow the coal to stand in a current of air warmed to from 80 deg. to 100 deg. F. for a period not less than twelve hours. Then weigh it and compute the percentage of moisture by this formula:

$$\frac{\textit{Weight moist coal} - \textit{weight dry coal}}{\textit{Weight moist coal}} \times 100 = \textit{per cent. moisture} \qquad (1)$$

When the sample lot has been reduced by quartering to about 1 oz. to 1½ oz., grind it in the mortar until

will pass through a 100-mesh sieve. This must be done rapidly to avoid any loss of moisture during the process.

Weigh out 5 grams of the powdered coal and put it in a 25-c.c. crucible. It is well in doing this to counterpoise the crucible on the balance and weigh the coal directly in the crucible, thereby eliminating any loss of coal by transferring it from the balance pan to the

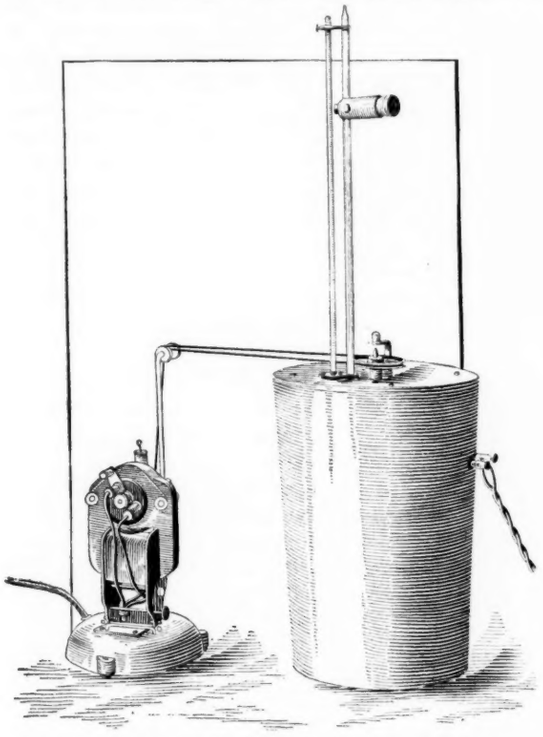


FIG. 2. CALORIMETER READY FOR TEST

crucible. Dry it in the oven for one hour at 220 deg. F. After this, cool it in the desiccator and weigh it. The loss indicates the amount of moisture in the air-dried coal. To calculate the percentage of moisture use formula (1).

Volatile Matter Also Determined by Heating

To determine the amount of volatile in the coal, weigh out one gram of the powdered coal in a 25-c.c. crucible after counterpoising the crucible. A platinum crucible is preferred, but one of porcelain will do. The volatile determination is similar to the moisture determination, but is made with the temperature at red to white heat and with the careful exclusion of air. If the coal is not very moist, as is the case of oven-dried coal, it is necessary to wet it slightly after weighing it in the crucible. This allows the air to be expelled from the crucible and prevents the oxidation of the coal. A piece of asbestos paper somewhat larger than the top of the crucible can be used between the edge of the crucible and the lid. This, being weighted down, acts as a check valve allowing the gas to pass off but preventing the ingress of air.

When these preparations have been made, heat the crucible with a bunsen burner capable of raising the temperature to a white heat. Heat it slowly for the first five minutes while expelling the air, then heat it to the limit of the burner for 15 to 20 min. It is well to have a metal chimney around the flame to avoid the effect of drafts of air. At the end of the heating period cool the test sample in a desiccator with the lid on. When it is cool, remove the lid and inspect the contents of the crucible to determine the coking power of the coal. Weigh and calculate the percentage of volatile matter by formula (2).

$$\frac{\textit{Weight of residue}}{\textit{Weight of coal}} \times 100 = \textit{percentage volatile.} \quad (2)$$

The process of ash determination is somewhat like the process of finding the percentage of volatile matter. The first step is to weigh out one gram of the powdered coal in a 25-c.c. crucible after counterpoising and weighing the crucible. Then place the crucible about three inches above the flame of a bunsen burner, the flame being about three inches in height. Allow it to remain in this position for 15 min. to permit the volatile matter to pass off, then lower it well down within the flame, leaving it in this position until observation shows a clean ash. This observation is important as the ash determination is very slow when the coal is burned in the open, depending on the atmosphere for

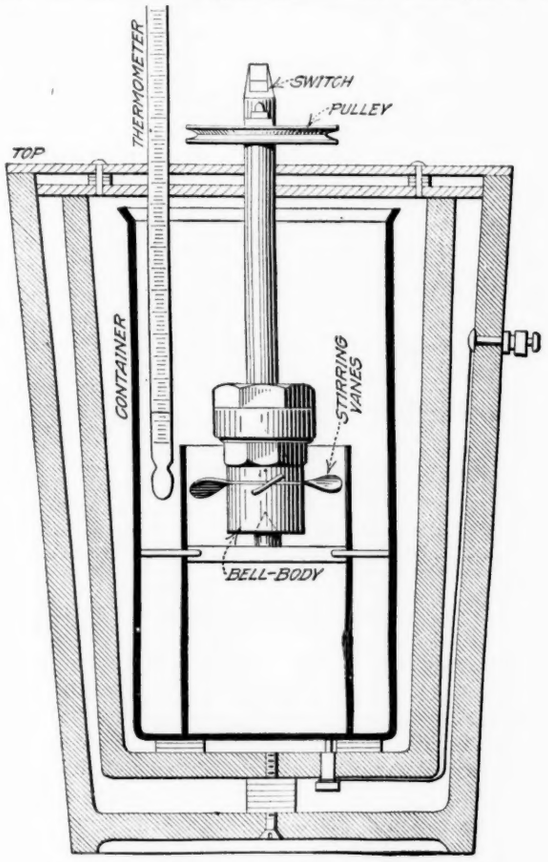


FIG. 3. SECTION OF COAL CALORIMETER

the supply of oxygen. Cool it in the desiccator and weigh it. Calculate the percentage of ash by formula (3).

$$\frac{\textit{Weight of ash}}{\textit{Weight of coal}} \times 100 = \textit{percentage ash.} \quad (3)$$

To find the percentage of fixed carbon, subtract from 100 per cent. the sum of the moisture, volatile and ash percentages.

Determination of the heating value is made by a Parr standard calorimeter. In preparing the charge, weigh out one-half gram of the oven-dry coal. In transferring the coal from the balance pan to the fusion cup

great care must be exercised not to lose any particles of coal. Before transferring the coal to the fusion cup, see that it is clean and dry. Weigh out one gram of accelerator ($KCLO_3$). If the accelerator is lumpy, it must be pulverized on a piece of glass with a spatula, preferably before weighing. Transfer the accelerator to the fusion cup with the coal. Then close it with the false cap and shake it vigorously for five minutes to insure a positive mixture. After it is well mixed, add one full measure of sodium peroxide (NA_2O_2), using the measure furnished with the calorimeter.

In filling the measure it should be tapped to insure complete filling. This must be done rapidly as the peroxide will absorb moisture. In adding the peroxide to the contents of the fusion cup, incline the fusion cup slightly to avoid blowing out the particles of coal. When the peroxide is added, close the cup again with the false cap and shake it, using the same precaution to get a good mixture. After it is well mixed, tap the false cap to remove all particles of the mixture from

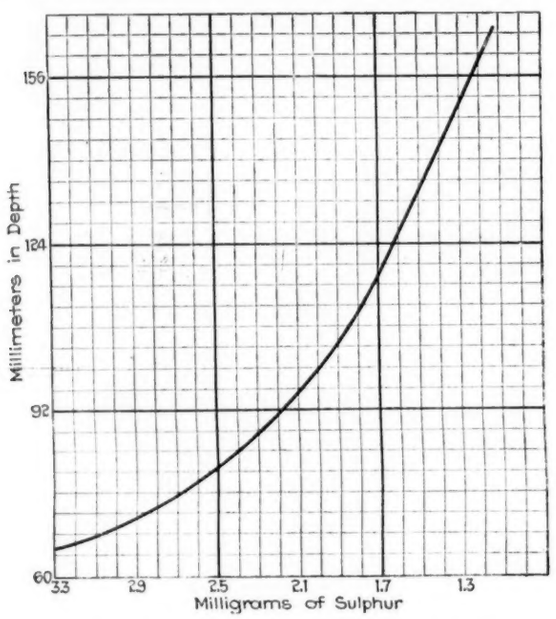


FIG. 5. SULPHUR PHOTOMETER CURVE

the upper part of the cup. Then prepare the ignition stem by attaching a piece of fuse wire about 2.7 in. (7 cm.) long to the terminals, passing it through the eyelets. Tighten it to insure good contact, allowing the loop to extend from three-eighths to one-half inch below the central terminal. Remove the false cap from the fusion cup and replace it with the ignition stem. Place the floating bottom at the lower end of the bell-body; place the fusion cup in the bell-body and insert the ignition stem; screw it down tight with the two wrenches. Put on the stirring vanes, allowing the small holes near the lower edge of the bell-body to be exposed. Remove the can from the calorimeter and fill it with 2 liters of water, preferably distilled. This water should be at a temperature of one or two degrees below that of the room. The room temperature should be, if possible, about 70 deg. to 80 deg. F. in order to keep well within the range of the thermometer. Place the container and top in place and see that the thermometer extends a little over halfway to the bottom of the container. Place the pulley in position on the stem, which should then be connected by a light flexible cord to the motor. The stirring is effected by the vanes on the bell body. The pulley should be revolved in a clockwise direction at about 150 r.p.m. Set the switch, being careful not to allow it to touch the ignition stem until the proper time. Allow the unit to revolve a few minutes before taking readings on the thermometer. Take the readings one minute apart for four or five minutes before igniting the charge, to insure an equalization of the temperature. To ignite the charge it is well to throw in the switch with a long stick to insure safety. After igniting the charge the temperature should begin to rise immediately. Take readings at one-minute intervals for nine or ten minutes. The readings must be carefully taken. If the temperature of the water before igniting is one or two degrees below room temperature, the temperature at the end of the first minute after ignition will be something over the room temperature and the radiation for that period may be considered self-correcting. Ordinarily, the rise in temperature will continue for four or five minutes, at which time the maximum will have been reached.

How To Find the Radiation

The radiation for this period is found as follows: Read the fall of the temperature for each minute for four or five minutes after the maximum has been reached. The average drop per minute represents the correction to be added to each minute preceding the maximum, except the minute immediately following the ignition. The final temperature thus corrected for radiation minus the initial temperature of the water represents the total rise in temperature.

From the total rise in temperature, corrected for radiation, subtract the correction factors for heat due to chemicals, fuse wire, etc. These correction factors are given in one of the tables. Then multiply the remainder by 3100 (the constant on the calorimeter). The product will be British thermal units per pound of coal.

It should now be noticed that the heat value of the coal as derived, refers to the coal in the condition in which it was weighed out for making the determination. That is to say, if coal having 14 per cent. moisture is oven dried before weighing out the portion for the calorimeter, the determination is for dry coal. To reduce this calculation to an "as received" basis, divide the number of B.t.u. obtained by 100 per cent. plus the percentage of moisture present in the coal obtained by determination.

TABLE OF CORRECTION FACTORS FOR CALORIMETER

	Deg. F.
Percentage ash, multiplied by	0.005
Percentage sulphur, multiplied by	0.010
Fuse wire	0.005
Accelerator, 1 gr.	0.270
Hydration, bituminous coal	0.070

Sulphur Content Found by Photometer

Determination of the percentage of sulphur in coal can be made by a Parr photometer. To obtain the sulphur content by this method, the residue from the fusion cup of the calorimeter is used. The first step is to place the material from the fusion cup in a large beaker after the cartridge is dismantled and pour hot water over it. In all add about 150 c.c. of water. Heat the mixture for five to ten minutes, then cool it and add enough pure concentrated hydrochloric acid (HCl) to neutralize the solution. Then add 5 c.c. of acid in excess.

Transfer the slightly acid solution to the 250-c.c. flask and fill it up to the 250-c.c. mark with pure water. Mix it thoroughly and then measure out for the analysis 25 c.c. of the solution in a graduated tube having a capacity of 100 c.c. Fill it up to the 100-c.c. mark with pure water. Transfer the 100 c.c. of solution from the cylinder to the Erlenmeyer flask and add 0.3 to 0.5 gram of barium oxalate powder, and without delay close the flask with the cork and shake vigorously for three to five minutes. Then allow it to stand for fifteen minutes.

To secure the turbidity, the solution is shaken and poured from the flask to the dropping funnel. The graduated tube is adjusted in the dark so that the rounded end dips well into the water in the flat dish, which should be about one-half inch in depth. Adjust the flame to a height of one inch; this is accomplished by having the flame appear one-eighth inch above the metal chimney.

By means of the pinch-cock admit the solution until the point of light from the candle flame just disappears; that is, until the last point of light from the flame is no longer visible.

Remove the tube and read in millimeters the depth of the liquid. By means of the curve shown herein, the milligrams of sulphur in the 100 c.c. of solution is determined. If 25 c.c. were taken from 250 c.c. before the light is observed and this later contained the fusion from ½ gram of coal, then the sulphur reading would be the weight present in $\frac{1}{20}$ gram of coal.

If, for example, the result shows 90 mm. in the tube there would be indicated 2.24 mg. of sulphur present in the quantity taken; that is 0.00224 gram. If one-half gram of coal is represented in this amount, there would be 0.0448 gram of sulphur, or 4.48 per cent., in the coal.

Special care should be taken to prevent the settling of the precipitate. A reading should be taken quickly and the contents poured back into the dropping funnel. Readings should be repeated several times to afford greater accuracy in the final average.

This method of making coal analyses has been used by the writer for some time with success. During a part of the time a woman who was employed in clerical work at the plant was used to make the analyses. The results given have been found to correspond closely with "check" tests made in independent laboratories.

Regulating the Frequency of Power Systems

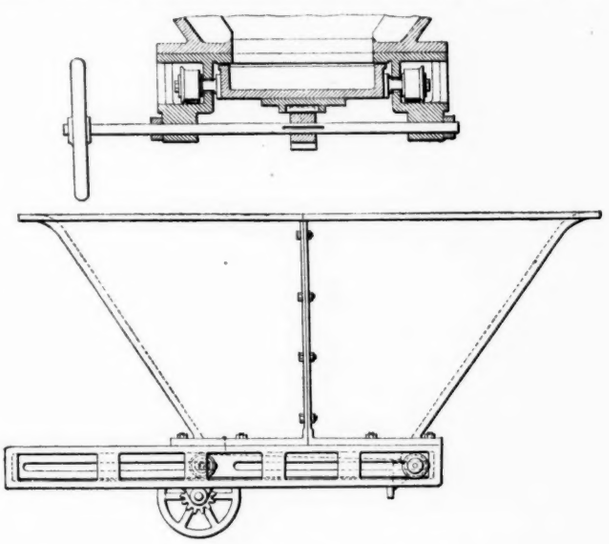
BY R. A. PHILLIPS

In large electrical systems consisting of several generating stations operating in parallel, it has been found best to make only one station regulate the frequency and to run all the other stations each at a definite load figure. The station regulating for frequency then takes whatever load changes occur, until the other stations can be made to increase or diminish their loads. It has been found that when all the stations in the parallel system undertake to regulate the frequency, great load transfers continually take place owing to the inaccuracies of the meters in the different stations and to the different ideas of the operators as to what loads their stations should carry.

The system operator makes up a load schedule for the entire day and apportions definite amounts of load for the different stations to carry; and the station with the largest number of units—which by their large number are usually of comparatively small size—is charged with taking whatever load swings are necessary to maintain constant frequency. Of course, over the valleys in the load curve at noon and in the evening, and at the times of day when the load increases or drops considerably, all the stations must change their load; and this figure is also worked out by the system operator.

Arrow Ashpit Gate

In large steam plants where stokers are used, it is common practice to discharge the ashes from the stoker into a hopper, thence by gravity into a larry car, from which they are discharged into a general ashbin, usually located over the railroad tracks convient for loading into cars. In very large plants a bottom-dump hopper beneath the stoker discharges directly into railroad cars, and with this system it is necessary to have a gate or valve to control the discharge of the ashes and to keep the openings tight when not in use. Recognizing that there is a field for an efficient ash-hopper gate, the Baker-Dunbar-Allen Co., Pittsburgh, Penn., has

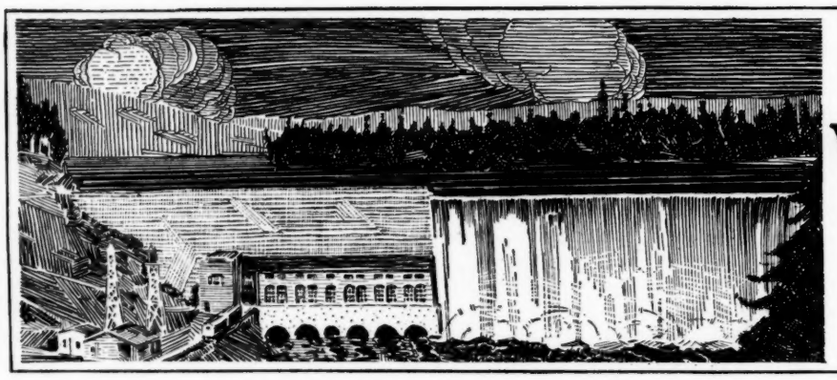


DETAILS OF ASHPIT GATE

developed a single and a twin gate known as the "Arrow," which is capable of taking care of practically any conditions that may arise.

The gate is made of heavy cast-iron sections, having cast-iron rollers. Being practically of cast iron in its entirety, it will stand up against sulphurous water, which is always present in hot ashes when water is used for quenching. As the gate operates on lubricated bearings, it is easily opened and closed. It will take care of any size opening necessary, being made for openings from 18 in. square to 3 x 5 ft.; that is, the bottom openings in the hopper can be made larger than the opening in the dump plate. Therefore, any clinker that passes a dump plate will pass through the hopper.

The gate closes against machined metal surfaces, which will remain tight as they automatically compensate for wear. It is lined with brick. It may be hand-, motor- or piston-operated with air, water or steam.



POP'S WATER-POWER COURSE

By

John S. Carpenter

POP stirred vigorously his third cup of the Greasy Spoon Beanery's standard brand of coffee, drained it, clinked the spoon down on the saucer and sat back studying Jimmy, who still struggled with a rubber tenderloin and wondered if death by starvation is painful.

"Jimmy," said Pop, "seein' as how I got three gages of this high-tension coffee in me, git Annie to give us a dozen of them catalogs called menus, an' I'll git to sketchin'."

Pop might just as well have spoken direct to Annie, the beautiful hussy with the granulated-sugar eyes, for she appeared presently with "them catalogs" and added the cheering remark, mainly addressed to Jimmy, that if she got fired for swiping the menus he'd have to support her for life, seeing that the Greasy Spoon was the only place in town that paid, counting tips, more than $35 a week.

Jimmy handed back the rubber heel, alias tenderloin, and told Annie that he preferred a peaceful end by starvation rather than a violent death by dyspepsia. Then he called for cigars, sipped his coffee now and then, and settled down to watching Pop make sketches.

"How did you ever come to learn drawing, Pop? Was it a case of early piety and late hours?"

"I guess that some Y. M. C. A. perfesser seed me drawin' my pay and 'lowed that I had considerable talent at that and hastily decided that the only way to keep me from bein' a bartender or some other kind of a regular guy was to grab me by the neck and lure me to his den. But what I'm a-tryin' to draw here is another of them ideal turbines like I drawed the last time we was talkin'."

"Uhuh," observed Jimmy, chewing the end of a five-cent Longshoreman's Delight.

"You see," assured Pop as he sat up from his painful efforts at drawing, "when you figgers a turbine, you goes at it from the tail end of the mule and works back. Now git out your pencil and figger. We'll say that in the case of our ideal turbine, we want 500 hp. and that we has 200 ft. head to drive it with. Now I figger, at 88 per cent. efficiency, 500 times 10, divided by 200, that's 25 cu.ft. of water per second that we gotta handle. Now," Pop pointed to the sketch, "we begin at the place marked 'curb ring' and we'll say that the velocity of the water at that point is that due to 6 per cent. of the head. So 6 per cent. of 200 is 12 ft. an' the spoutin' velocity for 12 ft. head is 28 ft. per sec., which I showed you how to find long ago. The area at that point is 25 divided by 28, or 0.89 sq.ft. In that table you got in that book, it says a circle 12½ in. in diameter is just a shade less than 0.89 sq.ft. in area, but it's close enough. From the conditions we hev given, a good designer would tell you that the runner would need to be about 22 in. in diameter to get a good shape of vane."

"Sposin' they made it less, then what?"

"Them vanes would be too short in the direction of flow—bent too sharp."

"So then the diameter of the runner isn't fixed by some hard and fast rule, but is a matter of judgment according to conditions?"

"Yep, it's a good deal like that. When we gits to studyin' other shapes of runners, you'll see that every rule has exceptions, as the guy says. Now, them gates is made so high that they has about the same velocity radial at the runner entrance as they is at the curb ring. When we comes to high-speed runners, you'll find that the radial velocity is purty high compared to the head. This entrance velocity at the runner inlet helps fix the angles that the runner vanes is bent to. That comes up in the velocity diagrams."

"It looks to me," observed Jimmy somewhat scornfully, "that with a little judgment and experience you could forget that there ever were such things as velocity diagrams or runner angles.

"Well," returned Pop thoughtfully, "a good many of the old fellers who made some of the standard turbines think so too. Our lecturer told me, confidential-like, as man to man, that some of them old fellers that's been at the turbine game for the last forty years or so couldn't tell you if velocity diagrams is a new 'flu' cure or if you play it on a pool table." Pop gave Annie the high sign for cigars.

"But so far we haven't said how many guide vanes, gates or runner vanes we're to have," Jimmy pointed out.

"We don't have to consider them yet. What you should have told me is that we ain't settled on the speed in r.p.m. of our turbine. Well, s'pose we make it 900 r.p.m., which is a good synchronous speed for 60-cycle juice. Seein' as how you agree to that, we'll now go ahead an' make the velocity diagrams. First, we'll figger the height or width of the runner. I said the velocity at that point should be about the same as in the curb ring. Divide 25 cu.ft. by 28 ft. velocity, which gives us 0.89, the area in square feet there. Multiply that by 144 to get square inches and divide by the circumference of the runner, the answer bein' 1.86 in. This is really too narrow for the runner width,

as it's likely to clog up. In such a case we got to be guided by common sense, which is the least common of the senses, and try a lower velocity. Let's try 20 ft. velocity there and figger it over on that basis. Now we gits an answer of 2⅝ in.—a hull lot better. Now rememberin' that this velocity is at right angles to the circumference, we draws it that way, to some convenient scale.

"Next, the runner is 22 in. in diameter, and runs at 900 r.p.m., or 15 turns per second. The runner circumference is 3.1416 × 22 = 69 in., or 5.75 ft., and 15 times this gives us 86.3 ft. per second for the peripheral velocity. Drawin' that in as shown, to the same convenient scale, we gits a parrylelogram when we completes the sides, and the diagonal gives us the direction of the beginnin' of the vane, the angle of the wicket gates and the velocity through the gates. Then, as soon as we say how many gates we wants and draws in some, the velocity diagram gives us the gate openin'.

"If we chooses too few gates, they'll be as long as between paydays; if we use too many, they'll be as short as a pocketbook after squarin' up a man's size grocery bill. Most builders have standards to which they sticks, lackin' better judgment and because somebody else got by with it before like that. So 20 gates looks about right, which we'll prove when they is drawed in. You sees that I showed 'em with a curve on both sides of the gates. Well, some people makes 'em like that and some makes 'em with straight sides, dependin' on which boss in the shop can holler the loudest and say, 'I wants them gates this way,' and bein' that they's no law agin' it, the fat guy gits his way on account of weight of opinion."

"How do you know, Pop, that the gate opening is correct, now that you've got it?" asked Jimmy, glad to get a word in, sardine style.

"I can prove it in a minute," responded Pop cheerfully.

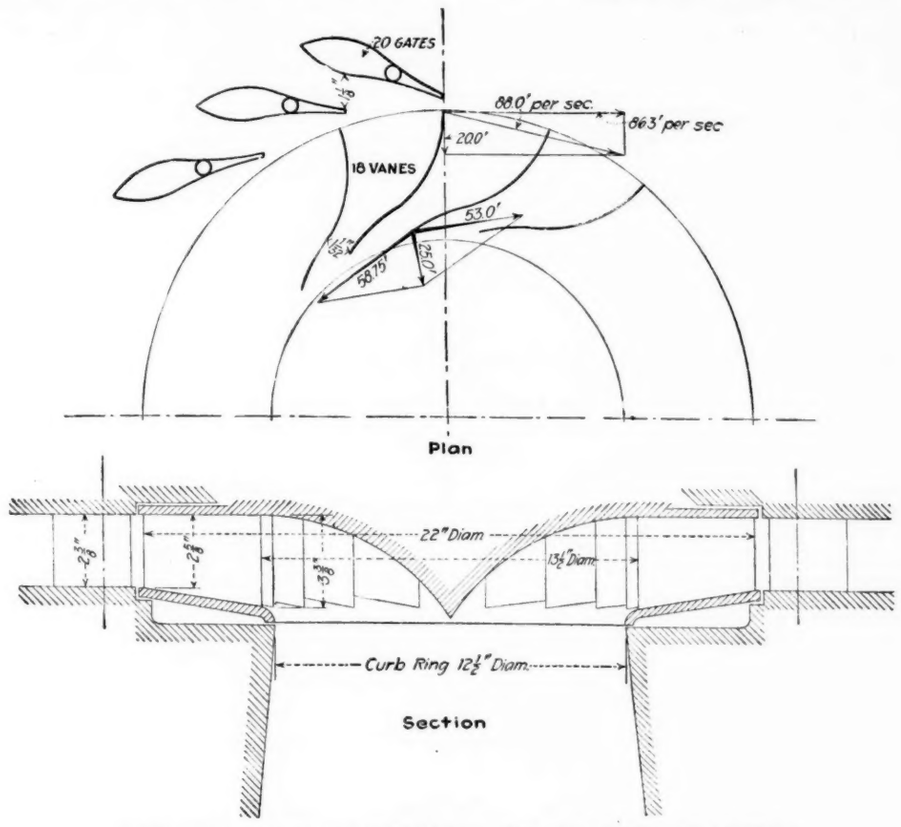
"Say," Annie broke in, "are youse gentlemen gonna camp here?"

"Fergit it, fair one. We're busy talkin' over the election prospects in Grass Lake, Mich.," replied Pop tactfully, though somewhat ruffled.

"Now continuin'," said Pop to the spellbound Jimmy, "twenty gates times 2⅝ in. times 1½ in. divided by 144 gives what?"

"Just 0.37 square feet."

"Now multiply that by the velocity, 88 feet."



SKETCHES SHOWING DIMENSIONS AND RELATIVE VELOCITIES

"The answer is 32.6 cu.ft. per sec. You got too much water, Pop."

"That's jes' what I'm a-comin' to. Thet 1½ in. is the most them gates should ever open to. That gives about 30 per cent. more water than 25 cu.ft. per sec., which is what we need for the turbine's normal load. When that turbine is connected to a generator, you'll find that for two, three or four hours, as the case may be, it's allowable to run the generator overloaded, and to git that you first got to have it in the turbine. For normal load the gate-openin' would be about ⅞ in., but as a fact, you couldn't git 30 per cent. overload out of the turbine, because both the turbine and the generator efficiency drops off at overload. All you'd prob'ly git is 25 per cent. more power."

Jimmy mumbled something to himself and then got the pencil going like mad. He was sure that he "had something" on Pop.

"Say, Pop, you got the overload at the gates all right, but not at the runner discharge. As near as I can figure, you have enough area at the ends of the runner vanes to get just 25.5 cu.ft. How in the Samhill can that pass 32.6 cubic feet?"

"This way," answered Pop. "When you opens them gates more than normal, you lets in more water, 'cause them gates acts sorter like the throttle on a steam engine, more or less, and that forces more water through the turbine because of the greater pressure in the runner, and increasin' that velocity of 58.75 ft. per sec. to whatever may correspond to the larger gate opening. See?"

"Hey, Annie," called Jimmy, with a dollar's worth of salve on every word, "the cigars are on me. Bring my favorite brand"—which was the only way that Jimmy could ever work off a "three-fer" on Pop.

"Tell me this, Pop. Why is it that the runner is made 2⅝ in. wide when the gates are only 2⅜ inches?"

"They gives the runner a little clearance so that they can be sure that the water gits in without buttin' up agin a square, sharp edge, as might be the case if the runner got outa line with the gate space."

"I think I understand the thing fairly well, Pop, so let's go on."

"I will if I ever recover from this thing you jes' handed me. I bet it's got an asbestos wrapper an' excelsior filler!" ejaculated Pop, throwing it with force into a handy "garbie." He gave Annie, who grinned from ear to ear, a wicked look, and turned to Jimmy. "The next time you wanna show yer frien'ship, jes' gimme a drink of barbed wire!" Then, in a more forgiving tone he said: "Now, they's some important points to git in this lesson today. The first is, that to git a certain power you need a certain size runner discharge, and to git a certain speed you need a certain runner diameter. Now suppose that you have to stick to a fixed, limited peripheral speed and that you want to increase the speed in r.p.m. That calls for a smaller runner until you find it darn hard to git in the size discharge you want and still keep the runner small to git high speed. It's like eatin' your pie and keepin' it. You can only go so far with keepin' the power and havin' high speed. That's the problem that's botherin' the turbine builders today. They all wants high speed in r.p.m. and high power. Now next time we'll see how they go about to git it, how they has to bulge the runner out so that its own mother would never recognize it, how they has to open the gates a hull lot more, and why they use what they calls a 'type characteristic,' which is another reason that chemical blondes marry plumbers."

Domes, Manholes and Steam Nozzles

By W. H. WAKEMAN

Certain developments in steam-boiler construction as observed by an engineer who has seen long service in the operating field.

THE first tubular boiler of which the writer had charge was fitted with a large steam dome. A separate steam connection for an injector was wanted; so a ratchet drill was rigged up and operations were begun. It took a long time to drill the hole because the cast-iron head, shown in Fig. 1, was 1¾ in. thick. As

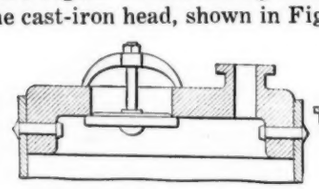


FIG. 1

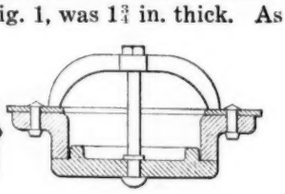


FIG. 3

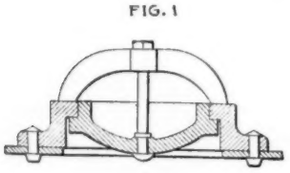


FIG. 2

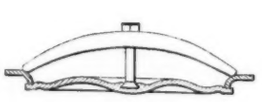


FIG. 4

FIGS. 1 TO 4. METHODS OF STRENGTHENING OPENINGS IN BOILERS

it was necessary to have a manhole in the head (there being no other way to enter the top of the shell) as well as a steam nozzle, the head was a very weak form of construction. A large hole was cut in the shell and was left with rough edges and without reinforcement of any kind, thus producing another weak spot. Such a boiler would be allowed to carry only a light pressure at the present day, but this one carried 80 lb. for many years, until the mill was burned.

The next improvement noted along this line is shown

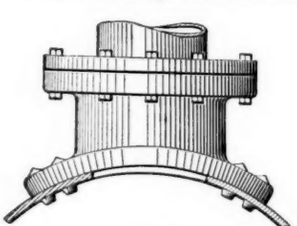


FIG. 5

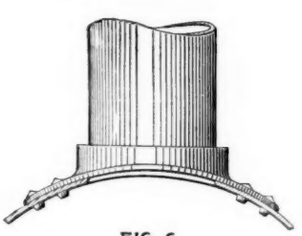


FIG. 6

FIGS. 5 AND 6. STEAM NOZZLES FOR STEAM BOILERS

in Fig. 2. It consists of a separate opening into the upper part of the shell, reinforced by a heavy cast-iron ring riveted on the outside of the shell. It is much safer and more convenient. Another improvement is illustrated in Fig. 3, in which the ring is located inside of the shell; hence, when pressure is applied, it forces the ring against the shell, and danger of leakage is greatly reduced.

Still more modern practice consists in turning the edge of the shell inward and milling the surface to receive a gasket, as shown in Fig. 4. Experiments have demonstrated that this form of construction is at least strong enough for all useful purposes, and it is much better than adding an extra ring, although no material is added to the original plate. It demonstrates that the form given to the material used is a factor in the case, as well as the thickness.

The separate manhole requires another fixture for the steam outlet, and one of the earlier forms is shown

in Fig. 5. It consists of a cast-iron nozzle riveted to the outside of the shell. The upper part forms a standard flange, to which is bolted another flange which carries the steam pipe. As the surfaces are not ground to a

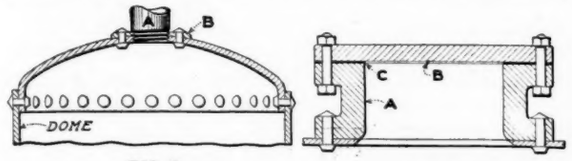


FIG. 7 FIG. 8

FIGS. 7 AND 8. REINFORCED OPENING IN DOME AND CONSTRUCTION OF CAST-IRON MANHOLE

perfect fit, packing must be used in the joint. When the packing must be renewed the boiler has to be laid off, as there can be no valve below this part by which the steam could be shut off. To overcome this objection and dispense with the use of cast iron the construction shown in Fig. 6 is employed. A steel saddle is riveted to the outside of the shell, and the upper part is turned and tapped to receive the steam pipe. It is lighter and stronger than cast iron and the appearance is satisfactory.

Where a dome is used at all on a steam boiler, it should be fitted with a convex steel head, as shown in Fig. 7. The steam pipe *A* is screwed into the top of the dome, but a reinforcing ring *B* is required to provide the thickness necessary to insure a good hold for the pipe threads.

The worst form of manhole and cover that the writer ever used is shown in Fig. 8. On the outside of the shell is riveted a cast-iron ring *A* to the top of which is bolted a flat, oval cast-iron cover *B*. The surfaces were rough and so a thick gasket *C* was used. The nuts were screwed down as far as possible when the packing was put in, making a tight joint at first; but after heat was applied, the packing would shrink, leaving it comparatively loose. It was not safe to tighten the nuts when steam was on the boiler, because when one was drawn up, it took more than its share of the stress and there was danger of stripping the threads or breaking the bolts. The failure of one bolt would endanger others in the joint and the whole might fail. The only safe way was to remove all steam pressure from the boiler, which was very inconvenient.

Certain boilers were built by a man who believed in the use of what he called a dome, illustrated in Fig. 9. It was a hollow cast-iron sphere *A* bolted to a cast-iron steam nozzle *B*. The steam pipe was bolted to the top at *C*, thus making two packed joints. Considered as a dome it is worse than useless and as a reservoir for steam it is only a little better, for two reasons: It is not large enough to hold sufficient steam to be serviceable and it is located near the boiler when it ought to be close to the engine. No kind of dome is of value as constituting a reservoir for steam. To be of any use the opening below it into the shell should be nearly full size. If it is small, as shown in Fig. 9, the velocity of the incoming steam equals that of the outgoing and there is a slight tendency to reduce pressure at this point. If it is reduced even one-half pound when there is a heavy demand for steam, water from the surface that is directly under the opening will be forced upward, causing wet steam to pass out of the dome. The water cannot fall back into the boiler because the velocity of the outgoing steam is too great. On the other hand, if the opening through the shell is ten times the area of the steam pipe, the rising steam will flow slowly. Not only does this prevent priming, but any water coming into the dome can fall back into the boiler. The objection to the dome is that it weakens the shell.

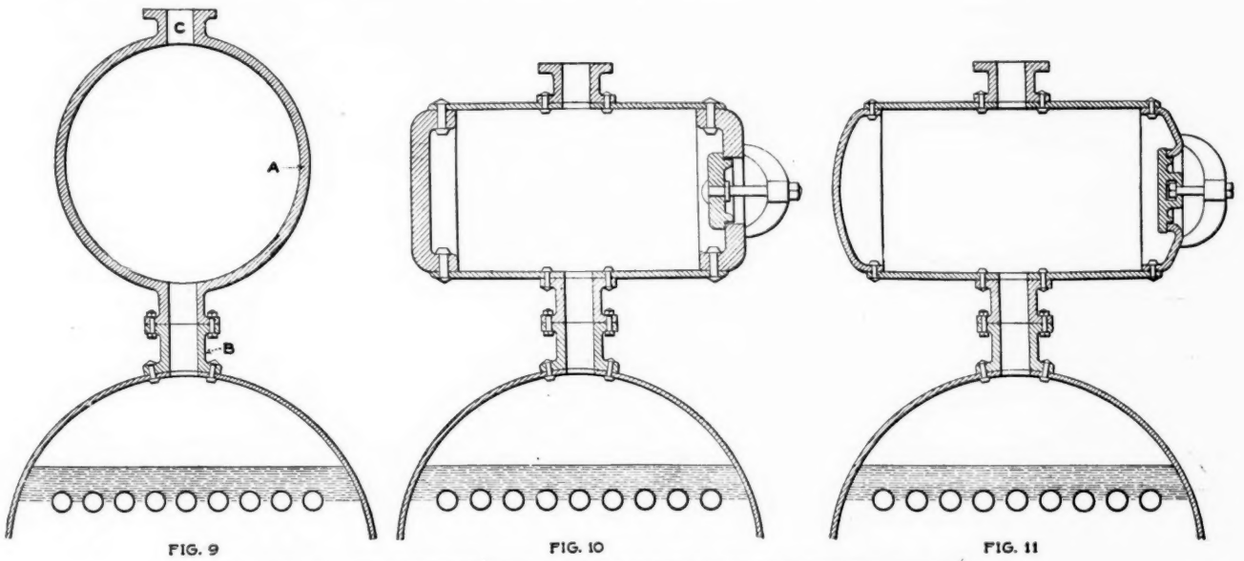


FIG. 9 FIG. 10 FIG. 11

FIGS. 9 TO 11. VARIOUS FORMS OF SO-CALLED STEAM DOMES FORMERLY USED

Other boilermakers have made these so-called domes larger, as shown in Fig. 10, but the principal result is more joints to be taken care of, without corresponding benefit. If domes are fitted with cast-iron heads, as shown, they are heavy and dangerous when used for high pressures, although the first cost is less than for convex steel heads, shown in Fig. 11. The latter are safe under any pressure that can be allowed on the shell, but in either case the device in the opinion of the writer is not of enough value to balance the first cost and pay for the room that it occupies.

A new hydro-electric plant will be erected in Taiwan, Formosa, under Government auspices. The company is capitalized at $15,000,000.

The Electrical Study Course—Two-Phase Systems

Hydraulic analogies are given of a two-phase alternating-current system, and then the discussion is continued to show how a two-phase system may be obtained from two single-phase generators or from one generator having either one or two windings on the armature.

TWO or more alternating voltages can be combined to provide what is known as polyphase systems; that is, systems in which more than one voltage is present. This is somewhat analogous to direct-current practice in which we may have a two-wire system supplied from a single source of voltage, or a three-wire one in which are combined several sources of voltage. In alternating-current practice the single-source system is referred to as a single-phase one, and the systems having more than one source as polyphase systems. There are two polyphase systems in general use: they are the two-phase system and the three-phase system.

The single-phase system we are already familiar with: for instance, either generator 1 or generator 2 in Fig. 6 would be a single-phase generator, and the wires leading from it would constitute a single-phase system.

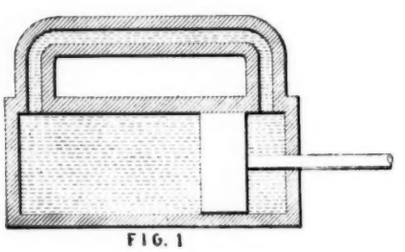


FIG. 1

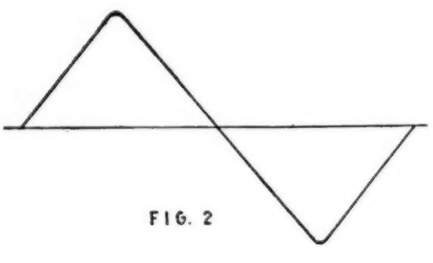


FIG. 2

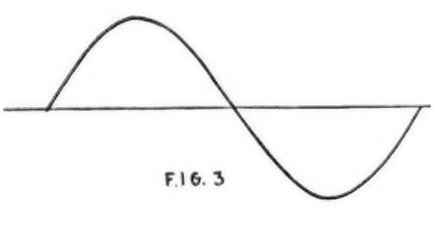


FIG. 3

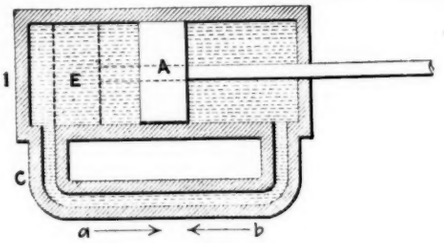


FIG. 4

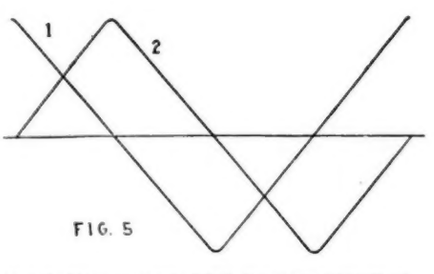


FIG. 5

FIGS. 1 TO 5. HYDRAULIC ANALOGIES OF SINGLE-PHASE AND TWO-PHASE SYSTEMS

The relations in the two-phase system may be illustrated by means of a hydraulic analogy. From another lesson we know that if the piston in a cylinder, such as that shown in Fig. 1, is moved back and forth in such a manner that the pressure increases gradually from zero at the beginning of the stroke to a maximum at the middle, and then again decreases to zero by the time the piston has reached the end of its travel, the variations in pressure for a complete forward and return stroke may be illustrated by some such curve as that shown in Fig. 2. If for the water pump we substitute an electric pump, for example the alternator No. 1 of Fig. 6, then its electrical pressure or voltage could be represented by a sine curve such as that illustrated in Fig. 3.

Suppose, now that we have two water pumps as shown in Fig. 4, and that they operate in unison, but that the piston *A* of cylinder 1 is set one-half a stroke ahead of piston *B* of cylinder 2. Water will be flowing at maximum speed through pipe *C*, in the direction of the arrows *a*, while there is no flow of water in pipe *D*. After a half stroke *A* will be in the dotted position *E*, and *B* in the dotted position *F*. The flow of water in *C* will have ceased, whereas that in *D* will be at a maximum in the direction of the arrow *c*. After another half-stroke, the flow in *C* will again be at its greatest value, but in the direction of the arrow *b*, and that in *D* will be zero. After still another half-stroke the flow in *C* will have ceased and that in *D* will be in the direction of the arrow *d*. The pressure in each cylinder can be represented by a curve, as in Fig. 2, but when the pressure in one is greatest that in the other is zero, and vice versa. This relation would be indicated by placing the curves in the positions shown in Fig. 5, in which curve 1 applies to cylinder 1 and curve 2 to cylinder 2.

In place of the two water cylinders let us use two alternators, such as those in Fig. 6. They are alike in all respects and are coupled together, but before coupling, the armature of one has been given a quarter-turn so that the taps *ab* on the winding of No. 1 are 90 deg. ahead of those on the winding of No. 2. Then the relations between the voltages will be the same as those between the pressures in the cylinders of Fig. 4. When the voltage of generator 1 is a maximum, that of 2 will be zero, and vice versa. The relation existing would therefore be expressed by two sine curves, each similar to the curve of Fig. 3 but spaced as shown in Fig. 7, in which E_1 represents the voltage of alternator No. 1 and E_2 that of alternator No. 2.

The two machines combined would be a source of two-phase voltage, and the four wires from them would constitute a two-phase system, of which the wires *AB* would be one phase and the wires *CD* the other phase. In general, a two-phase system is one supplied from two sources of alternating voltage, of the same frequency and of the same voltage, but with a phase difference of 90 deg. between them.

When there is no electrical connection between the machines, a voltmeter connected from a wire of one phase to either wire of the other will give no indications. If, however, a wire of generator 1 were to be connected to a wire of generator 2, as for example B to C, as indicated in Fig. 8, there would be an addition of voltages, since the voltage across AD would be equal to the sum of E_1 and E_2, and hence equal to the

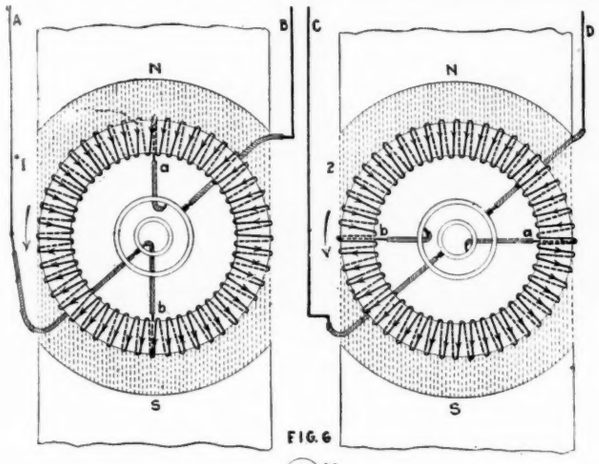


FIG. 6

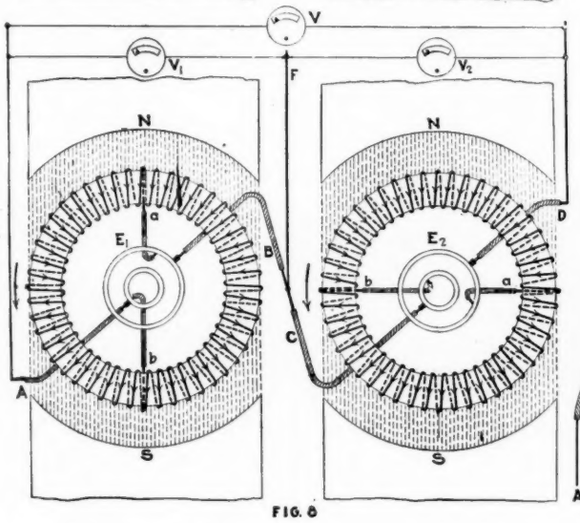


FIG. 8

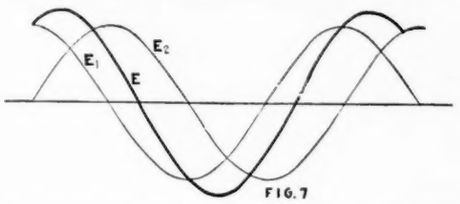


FIG. 7

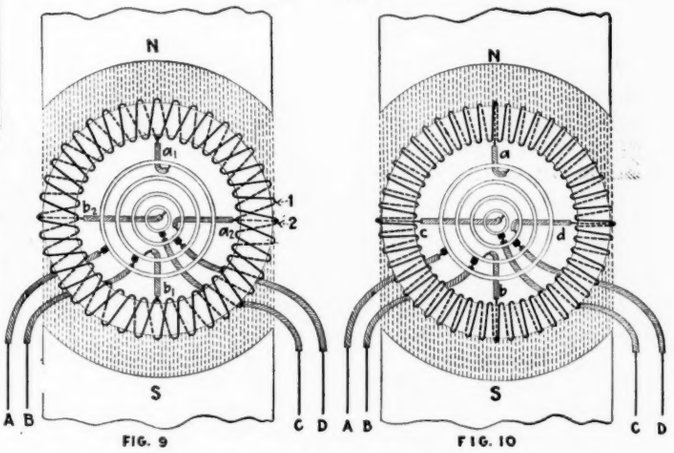


FIG. 9

FIG. 10

FIGS. 6 TO 10. COMBINATIONS OF GENERATORS AND WINDING FOR PRODUCING A TWO-PHASE SYSTEM

winding 1 connects to the wires AB and winding 2 to the wires CD, and these two sets of wires therefore comprise a four-wire two-phase system that differs in no respect from the one illustrated in Fig. 6, and they would likewise form a three-wire two-phase system if B and C were joined.

Another method of obtaining two-phase service from one armature is to use a single winding and tap it at four points, as shown in Fig. 10. The two phases would be AB and CD respectively. This method could not, however, be used for a three-wire two-phase system, since connecting B to C, for example, would be the same as connecting b to c, which would result in a short-circuit of the part of the winding between those two taps.

The first problem of the preceding lesson was to construct the vector diagram for the sum of two voltages, 100 and 150 volts, that are 120 deg. apart. The two voltages are represented by the vectors E_1 and E_2 in Fig. 11. To find their sum we add E_2 to E_1 as shown by

sum of the sine curves, as represented by curve E in Fig. 7. The maximum height of this curve is equal to 1.414 times the maximum heights of E_1 or E_2. Thus if V_1 and V_2 read 100 volts, V would read $1.414 \times 100 = 141.4$ volts. If a single wire F be run from the junction of B and C, we have a modified form of two-phase system called a three-wire two-phase system.

Instead of using two generators coupled together to furnish two-phase service, a single generator with two armature windings may be used, and in fact that is the method employed in practice. Thus, in Fig. 9, we have a single armature upon which are two windings, 1 and 2. The taps a_1b_1 of winding 1 are taken at right angles to the taps a_2b_2 of winding 2, as shown. Therefore the conditions governing the generation of voltage will be precisely the same as if we had the two windings on separate armatures as in Fig. 6. That is, the voltage across a_1b_1 will be at a maximum when that across a_2b_2 is zero, and vice versa. The machine is provided with four slip rings and one of the taps is connected to each. In Fig. 9 the connections are so made that

ab. The vector E, drawn from O to b, is therefore the sum required. Careful scaling would show its value to be 132 volts.

The second problem was to find the value of the sum of two such voltages as the foregoing if they were each

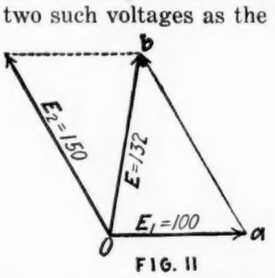


FIG. 11

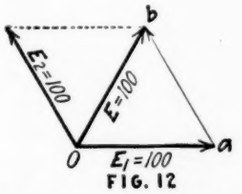


FIG. 12

FIGS. 11 AND 12. ADDITION OF TWO VOLTAGES 120 DEG. APART

equal to 100 volts. The two voltages in that case would be represented as in Fig 12. To add E_2 to E_1 we draw ab. It will be found that the sum E, found by joining O and b, is the same as E_1 or E_2: namely, 100 volts.

The Functioning of the Chain-Grate Stoker

By T. A. MARSH
Chief Engineer, Green Engineering Co., East Chicago, Ind.

The functions of the chain grate, depth of the fuel bed and grate travel, igniting arches, advantages of the waterback, elimination of air leakage, cleaning the air space, and an analysis showing why the ash is always at the bottom of the fuel bed.

ESTABLISHED as is the use of the chain-grate stoker, there still exist many vague notions concerning the actual functions of the chain grate and its accessories, the igniting arch, the waterback and other elements of furnace construction. The chain grate burns coal progressively. The green fuel enters the furnace at one end, passes through the various stages of combustion, and the ash is discharged from the furnace at the other end. To be automatic a stoker must feed coal into the furnace, carry it through the various stages of combustion, discharge the ash and refuse and keep the grate surface clean and ready for a continuation of the process.

All stokers may be divided broadly into two classes—those with traveling grate surfaces carrying the fuel through the furnace in a positive manner and those with stationary grate surfaces over which the fuel is advanced by some type of mechanism or by gravity. Chain grates come under the first broad classification, the layer of fuel of definite depth being carried into and through the furnace.

The Amount of Fuel That Is Fed

Two factors determine the amount of fuel fed—depth of fuel bed and the speed of grate travel. The depth of fuel bed is regulated by the fuel gate, which is a simple mechanism and should be easy to operate. Gates must be raised and lowered readily, otherwise operators will not regulate the fires with proper frequency, resulting in operation under improper conditions adverse to the best economy. Fuel gates are exposed on one side to furnace temperatures and therefore should be well protected by firebrick and tile linings, which are the most satisfactory for this purpose.

Grate travel is controlled by the speed of the stoker-driving engine or motor and the individual driving mechanism of each stoker. The engine or motor speed regulates all furnaces simultaneously to meet increasing or decreasing steam demands, but the individual operating mechanism of each stoker is used to regulate the individual furnace to insure the best conditions for efficient operation.

In general the expression "thin fires for capacity and thick fires for economy" is true, but it must be considered only relatively. Some fuels, such as lignites, give better results with thin fires. Coarse coal demands thick fires. Low draft prevents thick fires. Fuel beds from 4 to 10 in. thick are usual practice. Chain speeds vary up to 12 in. per minute, although many furnaces are so designed as to permit speeds of only 4 in. per minute. The higher speeds, say 6 to 12 in. per minute, are within limits of modern practice and are being obtained in everyday operation.

Discussion of chain speeds leads at once to the rate of ignition. Early chain-grate installations reached their limitation in the amount of coal that could be ignited. Short arches 3 to 5 ft. long, sprung arches, low-set arches and a number of other faults were responsible. The correct location, slope and length of the igniting arch are all important. Untold harm has been done by experimenters attempting to design and install arches in the absence of full knowledge of the stoker, furnace, coal draft, and in fact all elements entering into the ignition and combustion problems. The arch is a study for a furnace designer and should be so treated if proper results are to be obtained.

The function of the arch is to ignite the fuel, and

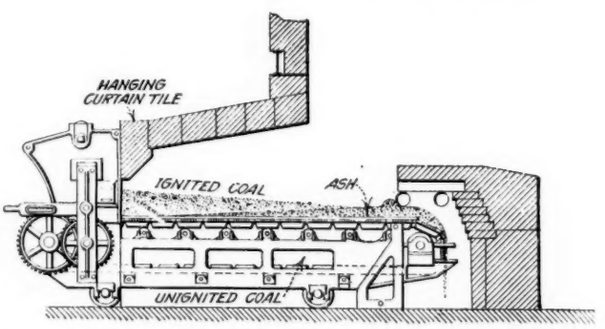


FIG. 1. ONE TYPE OF LONG FLAT ARCH, ALSO PROGRESS OF COMBUSTION ON CHAIN GRATE

the variables to be considered are: Combustion rate, percentage of volatile combustible in the fuel, calorific value of the fuel and the stoker length. Obviously, the higher the combustion rate desired the greater must be the provision for igniting the fuel. There are always two items, either one of which may limit the capacity—ability to ignite the coal and draft to burn it when once ignited. Therefore, since igniting ability increases directly with arch lengths, all other items remaining constant, longer arches must be provided for high combustion rates.

As the percentage of volatile combustible decreases, extra provision must be made to ignite the fuel. Fuel containing as low as 12 per cent. of volatile has been handled successfully on chain grates, but the problem of furnace design becomes highly special with such fuels. The higher the calorific value of the fuel the higher the furnace temperatures and the more intense the ignition becomes.

For many years arches were rather promiscuously applied in furnaces, and frequently stokers 11 and 12 ft. long were equipped with arches no longer than those provided for stokers 9 or 10 ft. long. Naturally, there was insufficient ignition to keep the grates properly covered, and in consequence long stokers fell into disrepute, many engineers contending that a length of 10 ft. was close to the limit. Recent practice, however, of making arches proportionately longer as the stoker length is increased, has rendered the grate area of long stokers just as effective as that in the shorter ones and has resulted in higher capacities from the larger units.

Ignition arches should be designed for their ability to ignite coal at certain rates per hour. The ignition rate is independent of the grate length, but to obtain similar combustion rates on longer stokers, the arches must be designed proportionately longer. Today, stokers 13 ft. long are producing high capacities, experiments indicate that 15 ft. is not beyond the limit in length, and there is no doubt that the demand for higher capacities will produce furnaces with chain grates in excess of 15 feet.

When arch lengths are to be determined, furnace designers take into consideration the four variables that have been under discussion. There is, of course, some latitude as bridge-walls of various designs and the type of arch employed have a marked effect. As an illustration Fig. 1 shows a flat arch that provides uniform height above the fuel bed from side to side of the furnace and uniform delivery of the gases to the boiler. It is unusually long. A hanging curtain tile at the front causes such air leakage as occurs between the front arch tile and the stoker gate to enter the furnace 12 in. or more below the lower surface of the arch. With the earlier constructions such air leakage chilled the front arch tile. In the arch illustrated this air not only does not retard ignition, but some of it doubtless enters into combustion and increases the furnace temperature. Arches can and are being installed to ignite 40 to 50 and even 60 lb. of coal per square foot of grate area per hour. With the present knowledge of furnace design, the ability to ignite the fuel should not be the limiting factor as regards capacity. No general rule can be given for arch locations

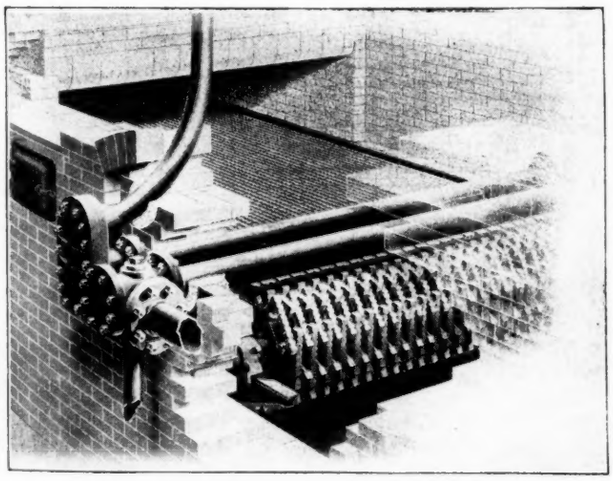


FIG. 2. A TWO-PIPE PRESSURE WATERBACK

for all boilers, coals, drafts and combustion rates. It should be realized that this is a problem by itself, involving also furnace volume, type of boiler, heat absorption, furnace maintenance and smokelessness.

Large Furnace Volumes

As fuel enters the furnace, the heat liberates the hydrocarbons or volatile constituents, which ignite and burn. The heat of this combustion is delivered to the boiler. Volatilization, ignition and combustion of the hydrocarbons occur almost simultaneously. In fact, when the time element is considered, the process seems more in the nature of an explosion, due to the rapidity with which it occurs.

In addition to long and suitably designed ignition arches, large furnace volumes are required for combustion, particularly of fuels high in volatile content. Few furnaces, in fact, have been designed sufficiently ample to completely accomplish this combustion process in the furnace itself. The necessity for large furnaces is being realized, and there should be much progress along these lines within the next few years.

Combustion of the Fixed Carbon

Theoretically, combustion of the fixed carbon in the fuel should not occur until all the volatiles have been distilled off. Practically there is no doubt that some

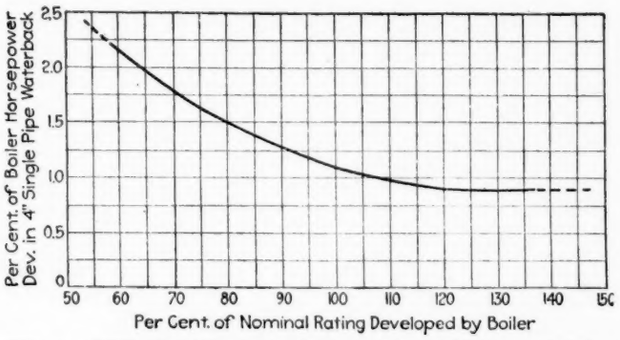


FIG. 3. PERCENTAGE OF BOILER HORSEPOWER DEVELOPED BY SINGLE-PIPE WATERBACK

combustion of fixed carbon occurs from the instant the fuel enters the furnace. It is evident, however, that combustion of the fixed carbon cannot become active until all volatiles have been distilled, so that the more rapid the volatilization, the sooner the active combustion of the fixed carbon can begin, and the more thorough will be the combustion by the time the fuel has reached the end of the grate.

The fixed carbon or the solid portion of the fuel is ignited under the arch and continues its combustion until burned out at the end of the grate. Naturally, as this fuel burns, the fuel bed tends to become rarer and in earlier installations permitted excess air to pass through the rear section of the grate. In plants of old design this was a source of loss, and even at this time it is not unusual to find engineers referring to the rare fuel bed at the rear of the chain grate as an inherent fault in this type of stoker. Such statements simply exhibit a lack of knowledge of the subject for in modern installations with properly set waterbacks, the fuel bed is more compact at the rear than at the front.

The Waterback and Its Functions

For this condition the waterback is responsible. Its functions are to compress the fuel bed, making the rear portion more dense than the front; to retain the upper or unburned portion of the fuel bed on the end of the stoker where the draft intensity is strongest, thus reducing carbon in the ash; to present a water-cooled surface to which clinker will not adhere, decreasing labor; to eliminate the burning off of bridge-walls, decreasing furnace maintenance.

Waterbacks at any height above the grate surface will accomplish the last two functions, but to accomplish the first two (and they are by far the most important) they must be set at a proper height above the fuel bed. To meet a variety of fuel, draft and load conditions, it is frequently necessary to vary this discharge opening. This requires a vertical adjustment

of the grate surface. Stokers having provision for such adjustment are therefore at an advantage over those that cannot be adjusted vertically without tearing out the brickwork and making a permanent change.

The height of the waterback above the grate is governed by the thickness of the layer of ash on the grate at the rear. If the ash is 3 in. deep, the waterback should be set 3 in. above the grate. With this relationship the coke on top of the ash will be retained and the fuel bed will be compressed against the waterback. Above all things waterbacks must not be set so high above the fuel bed as to barely come in contact with it. The discharge opening must always be sealed with ash, and the fuel bed must be compressed if high efficiencies are to be obtained.

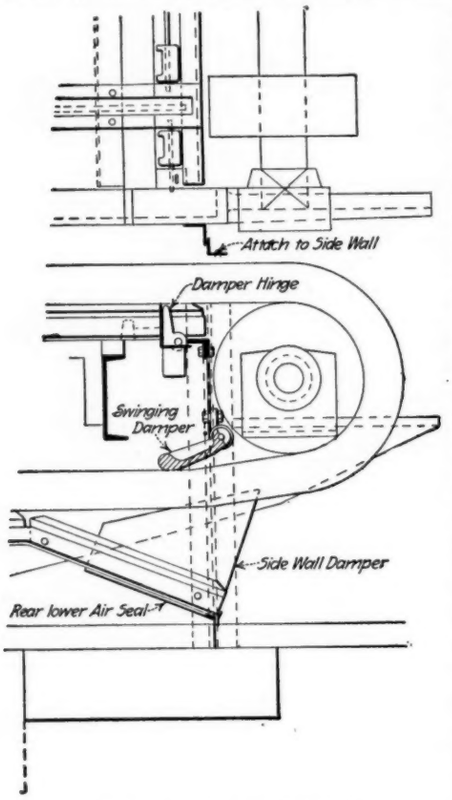


FIG. 4. REAR AIR SEAL

There are two types of waterback—plain and pressure. Their functions are identical, but plain waterbacks have circulation separate from that of the boiler, while pressure waterbacks (see Fig. 2) are connected to the boiler. The former type wastes the cooling water unless it can be used as feed water or in some plant process; the pressure type adds effective heating surface to the boiler. Fig. 3 gives an indication of the heat absorption in terms of boiler rating developed. The data were compiled by H. B. Dirks, mechanical engineer, from tests made at the University of Illinois. In the furnace under test and with a single-pipe waterback, the heat absorption varied from 1 to 2.5 per cent. of the total horsepower developed, an item not to be neglected in power-plant economy. Tests made by the Green Engineering Co., on a 752-hp. Stirling boiler with a double-pipe waterback, operating at ratings of from 130 to 225 per cent. of normal, indicated that the heat absorption varied from 2.5 to 3.5 per cent. of the total heat generated. Every engineer knows that it is a layer of ash that is discharged from the rear of the chain grate, but not every one has considered how and where this ash layer was formed. Fig. 1 indicates the structure of the fuel bed throughout its progress in the furnace. Ignition is effected by the arch above the fuel bed and is therefore a downward action. When the fuel bed is ignited thoroughly, as it is in the first few inches of travel in a properly designed furnace, combustion of the solid fuel must be from the bottom, as the air supply is from the bottom. The layer of ash starts, therefore, on the bottom of the fuel bed and increases in thickness until the entire fuel bed has changed to a layer of ash at the rear of the stoker.

Elimination of Air Leakage

Applying to practically all stokers and to hand-fired grates the fundamental rule of economy is to "keep the grate uniformly covered." The purpose of keeping the grate covered is to prevent air leakage into the furnace. This presupposes that with the grate covered there will be no leakage of "unauthorized air" into the furnace. Such is not always the case with the chain-grate stoker, although the better and more modern installations are so constructed as to prevent air admission other than through the fuel bed. In one type of stoker leakage is eliminated as enumerated in the following:

Between the sides of the stoker chain and the furnace walls air leakage is prevented by means of tight ledge plates. Adjustable members are necessary for a seal between the brickwork and the moving chain. Permanently fixed pieces burn away, warp or settle, destroying the air seal. Adjustable and renewable parts make it possible to keep this seal in order.

Through the rear of the stoker between the chains tight baffles stop the air, and a substantial baffle is also placed underneath the stoker between the lower lead of chain and the floor. In addition there are side-wall dampers between the stoker side girders and

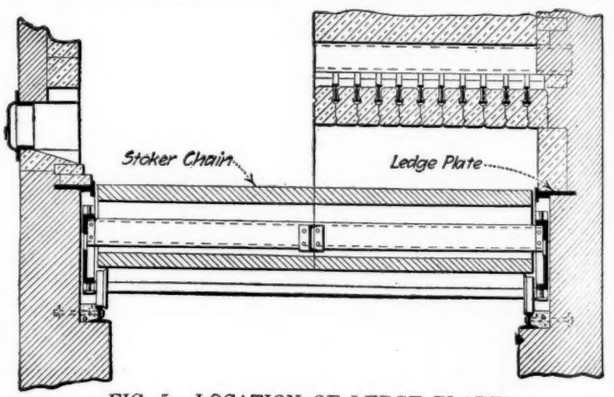


FIG. 5. LOCATION OF LEDGE PLATES

the furnace walls. The ashpit should be tight. Fig. 4, shows the rear air seal and Fig. 5, the location of the ledge plates. The effectiveness of these air baffles is a measure of the efficiency of the chain grate under operating conditions.

Cleaning the Air Space

Of the list of the four functions of an automatic stoker—feeding fuel, burning fuel, discharging ash and cleaning the air space—the first three have been discussed. The final feature of cleaning the air space is automatic with chain grates and easily accomplished. Staggering the links forming the grate surface causes a shearing action that frees the air spaces of accumulations of ash or refuse, leaving the grate clear and ready for a repetition of the process.

This study of the functioning of the chain grate should indicate the value of careful design in the grate itself, the arch, the waterback, the furnace and particularly the air seals. It should be evident that it is the refinements in the designs of these elements that are responsible for the high efficiencies now being obtained in chain-grate practice.

EDITORIALS

Power-Plant Accounts

IN THE keeping of power-plant accounts—and other accounts for that matter—depreciation is an item which makes the inexperienced all sorts of trouble and which in the hands of the experienced can be used to throw a balance to one side or the other.

Much of the confusion would be avoided if a clear understanding were had of what is meant by the term; whether for instance the purpose is to find the present worth of the plant or the average annual cost of running it over a term of years.

In making up the cost of producing an article or performing a service there must be included not only the cost of fuel, labor, oil, etc., but that of the engine, boiler and other plant equipment that is used up in the process.

If it could be known to start with how many kilowatt-hours or pairs of shoes or what-not the engine was going to turn out while it remained in the service, and how much its salvage value would be when it got through, it would be easy to tell how much money's worth of engine would be used up per unit of product. But this is not to be known in advance.

The cost does not need to be fixed, however, with such precision that it cannot be estimated and averaged. An engine will last with good treatment some twenty years. If to the other expenses of each year there are added five per cent. of the cost of the engine and this included in the selling price of the product; all of the money that was paid for the engine will be recollected from the users of the product by the time the engine is used up. The life of the engine might be taken at some other term than twenty years for some kinds of engine in some kinds of service, but the conception is the same. The engine is being used up year by year, and it is a question of making each year bear its average share of the total cost.

How much does it cost to wear a linen collar? One who thought no further than the laundry bill would say "three cents a wear." But a collar costs a quarter and will go say, ten times to the laundry. Then every time it is worn, two-and-a-half cents' worth of collar is used up. This is depreciation—used-up-ativeness—and handled in this way it is very simple, the only uncertainty being whether the collar will go ten times to the laundry or the engine will stay in the service under consideration the assumed number of years.

If an engine had to be sold at the end of a year's run it might not bring more than a half of what it had cost to buy it, set it up and pipe it ready to run. Not only would the engine be second-hand but all the costs of purchase, transportation, erection, piping, etc., would have been incurred for a single year's use of the outfit, and the things which the engine turned out—kilowatts, shoes, etc.—would cost an exorbitant amount of engine apiece.

But the engine is put in with the expectation that the business is going to continue, and if the probabilities were not strongly in favor of such continuation nobody would risk his money in it.

One might collect in the profits of the first year this remotely possible quick slump in the value of the engine to the business, and thereafter charge only such falling off in the value of the engine as actually occurred, which would be little if anything for a number of years.

On the other hand, another legitimate charge in making up the cost of a product is interest on investment. The cost of the engine is charged to the capital or investment account and interest upon this account is charged as a part of the cost of running the business. But when a portion of the capital so invested is recollected as a part of the selling price—that is, as depreciation—interest should no longer be charged upon it. The amount collected in depreciation should be credited to the capital account, and interest collected only on the unretired amount. Even if a business would stand the collection of profits which would retire half of the investment the first year, it would be simply withdrawing that sum from where it was earning a fair rate of interest, reducing the profit of the following years by the depreciation thus prematurely charged, and making it possible for the property, practically new, to be taken by condemnation at its depreciated value.

Perpetual Motion Wages

INDUSTRIAL unrest engages the attention of everyone these troublesome days, whether one be proletariat or a plutocrat, to use terms which economists have made familiar. Last week the power houses of the greatest electrical transportation system in the world were gasping on banked fires due to a strike, and these power houses are among the greatest in point of size and modern equipment. It was not a strike of power house crews, they merely went out when the nearly fifteen thousand employees struck. But they went out. And it is unusual for the power house crew of an establishment to strike when the other workers therein do.

Perhaps the participation in the strike by these crews presages nothing unusual. But the strike, as a whole, as one of many similar actions, is a symptom of deep-seated social unrest the end of which no man knoweth now. After tying up the metropolis for forty-eight hours the men were given practically all they asked for, and immediately the people rode to work instead of paying outrageous cab fares or walking. Everybody is happy—everybody but the stockholders of the company.

Everybody these days is out to profiteer, some in a small way others in a large way. The man in Wall Street who motors daily to his estate in Longshort Hills, the aproned commission merchant—even the peanut-stand man is doing it. And so one after another

of the various classes of consumers as classes of labor, strike, get a raise and go on.

Now one does not have to be a student of John Stuart Mills or Professor Laughlin to see that carried to the extreme to which we are headed this perpetual motion wage-raising trend is suicidal. If the cream cheese workers are raised twenty-five per cent the dispensers of the product use it as an excuse to increase the price forty per cent. And so it goes. Warren Stone of the Locomotive Engineers uttered sound sense when he told the Congressional Committee that raising wages would do his men little good. Reduce the cost of living, he said. That is what we all want; but we never will get there by the route that is now so popular.

The Selection of Electric Motors

A motor to successfully meet the requirements of the drive to which it is applied must develop sufficient torque to start and accelerate its load within a reasonable time without being subjected to injurious conditions. It must also be of such a capacity as to drive its load without undue heating, and have speed characteristics suited to the load. Of the two evils in the selection of motors it is always better to have the motor too large than too small. Since in the former case the motor will be capable of doing its work, where in the latter if it is heavily overloaded it will be only a matter of time before the high operating temperatures will destroy its insulation, and it will have to be rewound. However, there is no real advantage in selecting a motor that is unduly large and expensive to do the work. It would be a useless increase in cost to install a direct-current motor designed for adjustable-speed service on a drive that is always to run at a constant speed, or a compound-wound motor where the starting requirements are light and the load fairly constant.

If motors are selected too large the initial investment is not only higher than what it should be, but a machine too large for the work it is doing will be operating at a lower efficiency than one of the correct size, consequently with the large unit the yearly cost for power will be higher. There always has been the question as to whether or not the maintenance charges are not lower on direct-current machines operating at twenty to twenty-five per cent. below their normal full-load rating, than when carrying full load. However, with motors properly designed for the load they are driving there is no reason why they should give any more trouble when operating at full load than at seventy-five per cent. full load. In any case where the machines are given proper care the additional cost of installation and yearly cost of power will offset any reduction in maintenance that might occur with the under-loaded motors. With underloaded induction motors the cost of installation is not only increased and the motors operated at a lower efficiency, but they also operate at a lower power factor; thus requiring larger generator and transformer capacity, and a more expensive transmission and distribution system, with accompanying poorer voltage regulation.

Before an intelligent selection of motors can be made it is necessary to know the characteristics of the load to be driven, the starting and accelerating torque required, whether the load is constant or variable, the maximum peaks that the motors will be required to take care of, etc. The horsepower requirement is one of the most important items but not always the determining factor in the size of the machine. When motors designed for a twenty-five per cent. overload for two hours are applied to loads that are intermittent or variable, it is frequently possible to take advantage of the motor's overload capacity to drive the load during the peaks without overheating, with a considerable saving in the initial cost of installation. It is only by a careful study of all the elements affecting the loading of the motor that the best one can be selected for a given drive. With the present high cost of motors and in many cases of power an intelligent study of motor requirements in industrial plants apparently holds forth an opportunity for engineers to bring about a considerable economy.

Experience begets confidence. When the first two five-thousand-kilowatt generators were installed, about twenty-five years ago, at Niagara Falls, the engineer in charge of operation—now one of America's best-known electrical engineers—was afraid to parallel them until a third machine had been installed to take care of the load in case paralleling two of the units proved disastrous. However, the operator made a mistake one day and by accident paralleled the two machines and nothing happened. Today units of capacities not dreamed of in those pioneer days of twenty-five years ago are paralleled with systems of two and three hundred thousand kilowatts, almost as easily and with as little concern as any other daily operation about the plant. It is all very easy when you are sure of what you are doing—this is experience.

For a number of years past it has been apparent that the largest-capacity electric-power station units would be steam-turbine driven machines. However, with three 45,000-kilowatt hydro-electric units on order and the 50,000-kilowatt unit water-turbine machine under consideration, it is apparent that the single-unit turbo-alternator may have to take second place in size with its white-coal competitor.

Bonuses won't thrive in a plant where leaks are permitted to thrive. Every pound of coal, every quart of oil and every other little thing wasted represent just so much profit on the business lost and so much less money available for wages. Ask the manager of any department of a corporation what the budget is and whether or not wages figure in it.

Now that the war is over fuel oil is again coming to the front, the peace time industrial front. If the coal market does not put both feet on the floor and stay put fuel oil will see to it that this solid fuel makes its exit from many plants not to return right away.

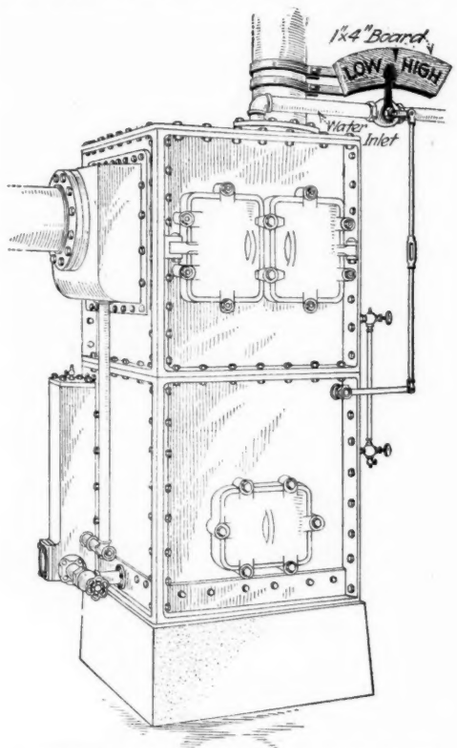
The difference between the good mechanic and the man who would like to be a good mechanic is the difference between actually doing something and merely wondering if it could be done.

We would remind those who predicted the utter failure of all the German ships hastily repaired by American engineers by welding that they are still in service.

Correspondence

Heater Water-Level Indicator

We have an open heater in the engine room where I am employed as engineer. Water enters at the top through a quarter-turn valve operated by a lever and a rod connected to a float in the heater. The heater is in one corner of the engine room, and the glass gage being at the bottom, I could see the water in the glass



HIGH- AND LOW-WATER INDICATOR

from only one point. The float valve would stick sometimes, but I would not know whether it was stuck or not except by going to see and, of course, I made many unnecessary trips to watch the water and try to keep it at the proper level.

I made an indicator from a piece of iron about 1½ in. wide by 12 in. long, cutting a square hole in one end to fit the end of the valve stem at the top of heater and shaping the other end as shown. I placed this pointer on the valve stem so that when the water was at the proper level it would stand plumb. I also made a board fast to the heater and marked it where the pointer should be. This pointer is moved back and forth by the float as the water level in the heater changes. If the heater becomes dry, or nearly so, the pointer will indicate it by pointing to one side, marked "Low" on the board, and when the water gets high it will point to the high side.

From any part of the engine room I can now see where the water level is and it has saved me considerable walking.

J. R. WEBB.

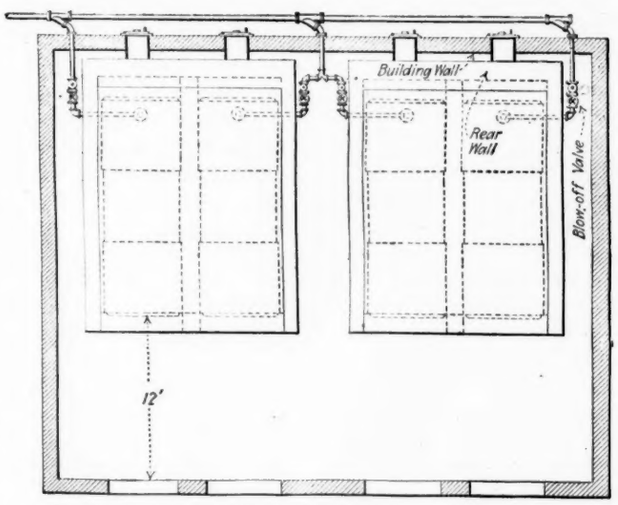
Parkersburg, W. Va.

Return-Tubular Boiler Setting

The accompanying illustration shows a method of installing horizontal return-tubular boilers which I have long advocated. The rear wall of the setting is close to the boiler-room wall and the clean-out door is opposite another door in the rear wall of the boiler room, so that all the dirt from the boiler is taken directly outdoors. This results in a reduction in the amount of room required in the building, and prevents dirt from the boilers being carried through the boiler room. Incidentally this setting prevents the space ordinarily left behind the boilers from being used as a storehouse and a general catch-all for all kinds of rubbish.

In this method of installing the boilers must be set in batteries of two, in order that the blowoff valves may be properly arranged and easily reached, but this makes it much easier to make repairs on either or both of the boilers, a situation that should be appreciated by those who have this work to do.

Another point in favor of this kind of setting is that the space between the front tube sheet and the front wall of the boiler room is considerably less than the tube length, leaving only sufficient room for such coal storage as may be required and proper firing space to handle the coal and the firing tools. In case it is required to remove tubes, they may be taken out through doors or windows. With boilers having 16-ft. tubes, the firing space may be cut to 12 ft., thus saving 4 ft.



PROPOSED BOILER SETTING

at the front, which, with the 4 ft. from the back of the boilers, makes a saving of the 8 ft. in length of the building.

This will result in a very considerable saving in money and, I believe, in no reduction in the convenience of operation. As a general thing but little attention is given to boiler-room conveniences.

Boston, Mass. HENRY D. JACKSON.

Air-Compressor Losses

While watching the valve gear of a 33 x 36-in. air compressor perform recently, the inlet valve at one end appeared to be closing late. Turning the engine over by hand slowly, I found that the piston had traveled one inch when the valve closed. The compressor is equipped with an inlet valve the opening of which is effected by a cam and the release by a separate eccentric. The discharge valves are of the poppet type, and the machine ran 54 r.p.m. at the time.

The loss of one inch of the stroke meant a loss of 26.7 cu.ft. of air per minute. That in itself was worth

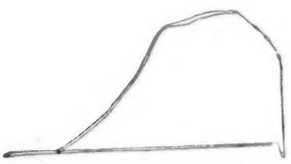


FIG. 1. FIRST DIAGRAM

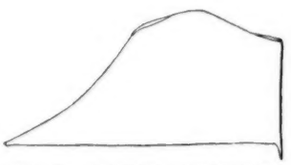


FIG. 2. SECOND DIAGRAM

saving, but suspecting that the effect of inertia on the closing would make the loss more serious, I rigged up an indicator connection and got diagram, Fig. 1, which showed that before closure was complete the piston had traveled 6½ in. This indicated a loss of 173.6 cu.ft. per minute, or 18 per cent. for one end. Advancing the closing eccentric resulted in the diagram, Fig. 2.

This compressor is one of a pair driven by two engines connected to a common shaft with the cranks set at 90 degrees. The unloaders were set to operate one end of each compressor at the time, the unloading being abrupt and complete and the valve remaining open during the unloaded period. The governor was equipped with an oil dashpot.

When I took charge of the plant, the governor was out of commission, the engines running on the throttles; the unloaders were also out of service. After getting the governor fixed, I foolishly filled the pot with cylinder oil, thinking that would give better results in regulating. Not so, however. At every operation of the unloader the speed would increase until the governor would get control of the situation, and perhaps by that time the unloader would be ready to dump the load on again, when the speed would go in the opposite direction.

I exchanged the cylinder oil for engine oil. There may have been some improvement, but I couldn't notice it. In desperation I disconnected the dashpot from the governor with the result that the regulation is about as even as one could wish it to be, but the governor is a busy one.

R. McLAREN.

Toronto, Ont., Canada.

Heating of Banding Wires

The trouble experienced by C. D. Corwin from heating of the banding wires of a self-excited alternating-current generator, as related in the May 27 issue of *Power*, was probably due to eddy currents, since the armature was free from grounds.

It is possible that when the machine was first rebanded with steel wire, the wire was oxidized, which would considerably increase the resistance to the flow of eddy currents. If the wire used were free from oxide on its surface, the bands would then be comparable to a solid mass and offer a path of low resistance to the flow of eddy currents, with a resultant increase in heating from this source. Better results might have been obtained if the clips were insulated from the bands, unless they were soldered to the former.

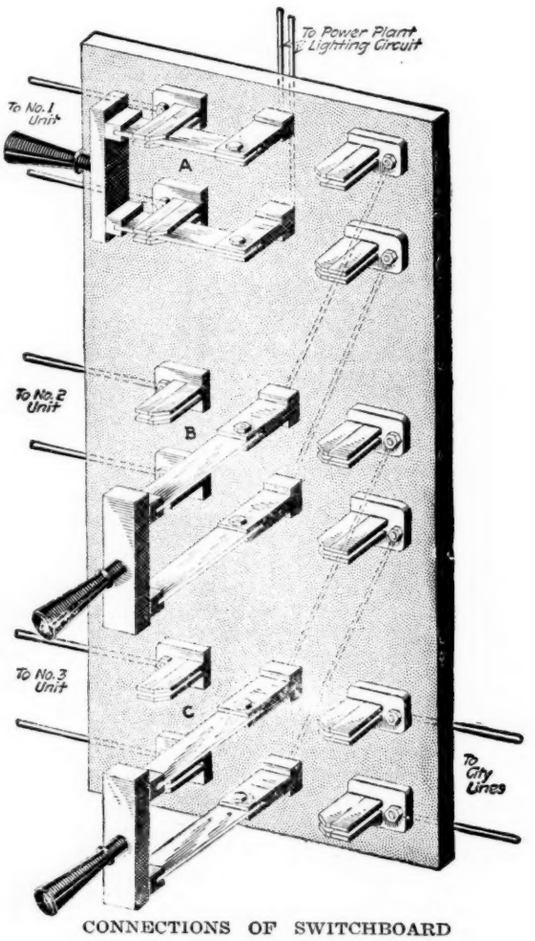
Utica, N. Y. C. R. BEHRINGER.

Emergency Lighting Switchboard

In some industrial power plants when the circuit-breakers fly out the power plant is left in darkness, making it difficult to get around. This can be overcome by using a small switchboard, which can be installed at little expense.

In the illustration the switchblades at the left are connected to the generators and those at the right are jumper switches with the exception of the one for the city line. With this arrangement the lights can be taken from any unit that is operating, and the operator cannot throw the machines together by mistake.

In order to take current from No. 1 machine, throw the top switch *A* to left; to take current from No. 2 unit, throw the upper switch *A* to the right and the second switch *B* to the left; to take current from No. 3



CONNECTIONS OF SWITCHBOARD

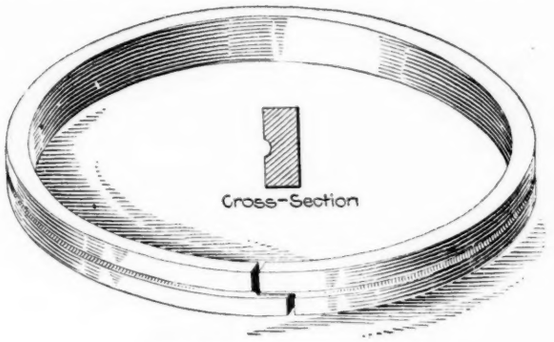
generator, throw both upper switches *A* and *B* to the right and the lower switch *C* to the left.

When it is necessary to take current from the city line, throw all the switches to the right. It is well to have the polarity the same on this board at all switches, as otherwise there may some time be a little difficulty, as astatic ampere meters with illuminating lamp and dial may cause a reversal in the ammeter.

Hartford, Conn. F. W. SCHNEIDER.

Diesel-Engine Piston Rings

It is generally conceded that the employment of two piston rings per groove is inadvisable on Diesel Engines. Nevertheless, an engineer is frequently found who insists on following this bad practice. His excuse, usually, is that a broad single ring has a tendency to scrape the oil off the cylinder walls, causing worn liners.



GROOVED PISTON RING

It must be admitted that many instances have occurred where the broad ring was guilty of doing this. The best remedy, however, is not the use of two rings per groove, but the engineer should file or cut a small groove on the circumference of the ring about midway on the wearing surface as shown in the accompanying illustration. This oil groove serves to break the width of the ring surface and assists in distributing the lubricating oil.

E. E. SNOW.

Philadelphia, Penn.

Keeping Feed-Water Heater Clean

In line with the suggestions offered by L. A. Higgins on page 502 of *Power* for Apr. 2 the following is submitted:

I have a 200-hp. vertical heater with a separator directly above it. The original packing on the upper head of this heater lasted 23 years and that on the lower head 24 years. When these were renewed, there was absolutely no accumulation of cylinder oil on the coils in the heater. I have a 300-hp. heater with a separator above it in exactly the same position. This has been in service for 17 years. The exhaust steam from three engines, five pumps and an air compressor passes through these heaters, yet there is no accumulation of cylinder oil in the boilers. Is not this more or less proof that both heaters and separators are in the right place?

In my practice as a consulting engineer I was requested to devise means for cleansing the exhaust steam from a large factory engine, and recommended a certain separator, advising that it be located just beyond the heater. Several months afterward word came that the separator was not satisfactory. Investigation showed that the instructions had been disregarded and the separator located near the engine. It was taken out and placed beyond the heater. Some time afterward it was reported that the exhaust steam was perfectly clean, although no other change had been made. Although the change was expensive, it has proved a good investment.

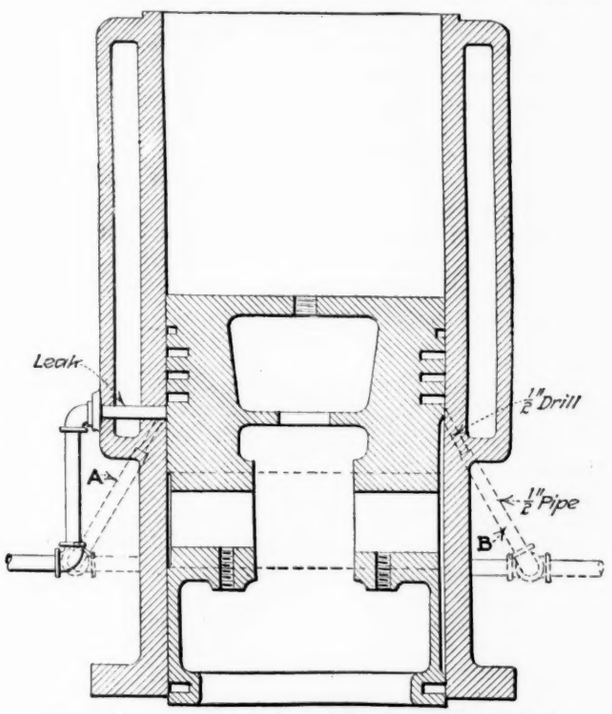
W. H. WAKEMAN.

New Haven, Conn.

Experience with Producer-Gas Engine

Here is a peculiar experience (though not my own) with a producer-gas engine:

It seems that all at once considerable water was noticed in the crank case of a 100-hp. three-cylinder vertical engine. The oil level was abnormally high for no apparent reason, and search revealed the presence of considerable water in the crank case. Where did this water come from? It was drawn off, and when the engine was started water was seen to be rising again gradually. This time a search revealed water coming from around the oil ring at the bottom of the piston. It was decided that only a cracked cylinder could produce this, and accordingly a new cylinder was ordered and installed. The old one lay around for some time, and suddenly one of the other cylinders began to show signs of the same trouble. This time the chief began to do some thinking. As it was during the war and new cylinders could not be obtained readily, the old one was made ready for a test by water pressure to determine just where the crack was. It was found to be coming from the nipple that was screwed through the outer wall of the jacket, through the water space and the inner wall of the cylinder. This was a ½-in. nipple and was found to be corroded through in one spot. It was not a cracked cylinder wall as was at first supposed. Removing the nipple,



HOW OIL-FUEL LINES WERE RECONSTRUCTED

putting in a brass one and making a tight job made a good cylinder for emergencies. It was a simple matter to make new nipples for the other two cylinders and a few more for emergencies.

The illustration shows the location of the leak in the nipple, also the other details of the oil-feed lines as now constructed. These lines, *A* and *B*, do not pierce the water jacket as is the case in the old style of construction and for that reason make a better arrangement.

D. L. FAGNAN.

New York City.

Engine Crosshead Pounds

I advise Mr. Hollis to give his engine a little more compression on both ends, also a little earlier steam admission on the end of the cylinder giving the left-hand diagram, shown on page 827 of the May 27 issue of *Power*.

In regard to the necessity of keying up the crosshead brasses every other morning, I suggest that he remove the brasses and refit them to the wristpin, as they are doubtless pinching on the top and bottom and do not have a bearing at the sides.

Willsboro, N. Y. C. RICHARD WARD.

The diagram submitted by E. Hollis shows inadequate compression for an engine making 81 turns per minute. An engine running at that speed should have the compression run up to at least one-quarter the height of the admission line. To obtain the required compression in this engine without restricting the release due to later opening, it will be necessary to advance the eccentric. This will cause an earlier opening of the steam valves, which can be remedied by lengthening the radial rods and shortening the dashpot rods. To obtain smooth running with an engine running under, it is essential that there be no play between the guides and the crosshead shoes.

In reference to the engine pounding only on one end, I would say that the compression is less effective on that end. In other words, the thrust on the bearings has not been reversed before the steam is admitted for the opposite stroke. When the boiler pressure is increased, the knock increases because the initial pressure against the piston is greater, resulting in a greater impact against the wristpin. In some cases slightly late admission where the compression has not been effective will alleviate a pound. This is because the reciprocating parts are in motion when the steam is admitted against the piston. J. W. DICKSON.

Memphis, Tenn.

Having read the letter of E. Hollis, I submit the following facts for consideration.

A friend had charge of a 20 x 48-in. engine. The speed was 60 r.p.m. and the boiler pressure was 80 lb. The crankpin began to heat badly. Cylinder oil was substituted for engine oil, without securing better results; then castor oil was used, followed by white lead. As it was necessary to shut down every day to cool off this pin, the trouble proved expensive. The engineer recommended a set of new crankpin brasses, but after these were fitted the crankpin continued to heat as before. He then called for a new crankpin, but this was no better than the old one.

All this trouble called for much overtime and extra work and worry, until the engineer was obliged to take a vacation. The substitute engineer was given permission to make any change that he desired during the absence of the regular man. He proceeded to take some indicator diagrams, which were practically like those shown by Mr. Hollis, except that there was no compression. Connections between the wristplate and the exhaust valves were lengthened, thus increasing the compression until it was equal to about one-half of the initial pressure. The crankpin did not heat after this change was made, using a good engine oil only, and no other changes were wanted or made. The engine did not pound either before or after the change was made. W. H. WAKEMAN.

New Haven, Conn.

Discussing Mr. Hollis' engine trouble, it looks as though both exhaust valves were leaking and that both close too late, especially the one on the left diagram. I advise adjusting the valve connections to close the exhaust valves earlier and thus get more compression which is the first step in relieving the pound.

Next, see that the piston rod is parallel with the bottom guide when the crank is on the crank-end center, either by putting a level on the rod and guide or by using a caliper between the piston rod and the bottom guide, bringing the rod level and parallel to the guide by adjusting the wedge on the bottom shoe to raise the crosshead. The rod will then run true through the stuffing-box. If the crosshead is already in line and parallel, the top shoe should be adjusted so that it will be as tight as it will run without heating. This is necessary on all engines running under.

As the engine is adjusted by means of a key and strap, they may be so pounded up that they will not stay tight with the engine carrying a varying load. It would be well to take out the key and file the edges where they pass through the strap, running the file lengthwise of the key, thus making it fit more perfectly. Perhaps the setscrew has worn a bad spot in the side of the key, which requires scraping out to make the key hold better. See that the nut on the end of the wristpin has not loosened and allowed the crosshead pin to work loose in the crosshead.

If these mentioned remedies fail to give relief, key the wristpin brasses up as tight as it is safe to run, start the engine slowly and hold the hand over the end of the crosshead pin, allowing the fingers to touch the crosshead at the same time as the pin when the crosshead reaches the end of the stroke and while the crank is passing the centers on both ends. In this way one can tell if the crosshead pin is loose in one side of the crosshead, which will also cause a pound. If it is loose, it should be refitted at once to prevent the hole in that side being pounded out of true beyond repair and to avoid the possibility of the crosshead being later cracked on the other side by the bending movement of the crosshead pin in the tight side.

Again, while the engine is running slowly notice if as the crosshead reaches the ends of the stroke, it jumps sidewise. If it does, the brasses are worn out of true and this throws the connecting-rod out at a slight angle, causing the crosshead to jump sidewise. The brasses should be taken out and trued up on the bearing surface and squared up if necessary to keep the thrust of the piston rod and connecting-rod on a straight line.

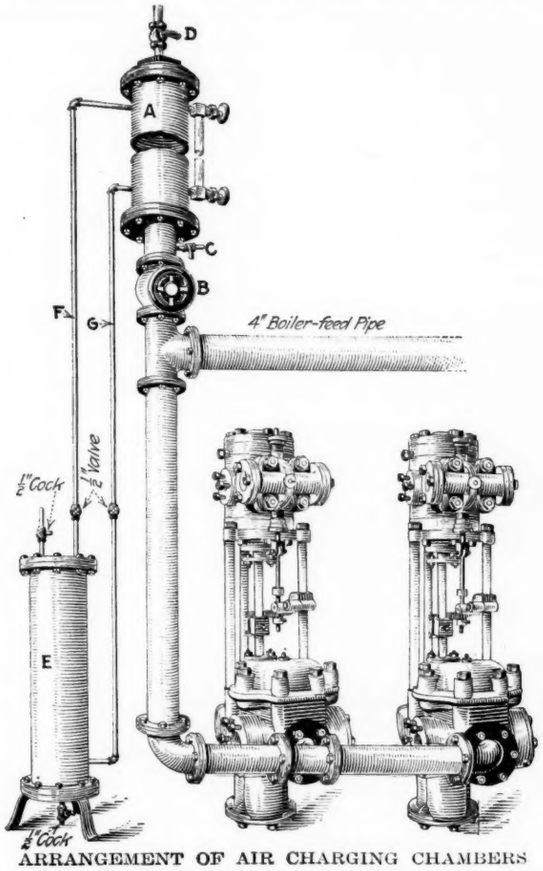
If, after filing the key and strap true, the former should protrude through the strap, it may be necessary to put a small sheet-steel or tin strip in back of the key to hold it up in position until a new one can be obtained. Also see that there is no obstruction for the key to strike against below the crosshead, if the key extends through the strap too far. The key may be extending far enough through the strap to strike the crosshead when the connecting-rod reaches its greatest angle when passing the quarter, which will also cause some pound and it may produce a serious break.

Cambridge, Mass. R. A. CULTRA.

Maintaining Air in Air Chambers

The desirability of air chambers on boiler-feed lines, at least when reciprocating pumps are used, is, I think, recognized by most engineers. The fact that they have been abandoned in many plants is probably due to the difficulty of maintaining the necessary air cushion and the engineer has balked at the thought of purchasing an expensive and troublesome air pump. So the jarring and hammering of the feed lines has been regarded as a necessary evil. Perhaps the following may be of value:

At a plant where I was recently employed, the boilers were normally fed by a four-stage centrifugal pump, with a large vertical reciprocating pump as a stand-by. Both of these machines were put out of service by sand



ARRANGEMENT OF AIR CHARGING CHAMBERS

which found its way from the filtration plant, and two small reciprocating pumps of one-half the capacity of the large machines were installed and put to work. These were connected to a common suction pipe about 80 ft. long, and it was at once apparent that it would be necessary to allow them to fall into step owing to the pulsating action of the water column in the suction pipe. The effect of this synchronizing was, however, to set up heavy pulsation on the discharge side, which caused the boiler-feed check valves to clatter and which also broke a tube in the economizer.

An air chamber *A* was then placed on the discharge side, consisting of 6 ft. of 8-in. pipe with a plug at the top, a water glass being fitted so that the air volume could be observed. This air chamber was put in operation by first closing a 4-in. valve *B* at the bottom and drawing the water from it by means of ½-in. cock *C* just above the latter valve, while the air entered through another ½-in. cock *D* at the top. The 4-in. valve was then opened and a small air cushion formed.

Although no leak could be detected, the air volume gradually decreased, due perhaps to its absorption by the water, and the necessity for some kind of air pump was obvious. The average pressure in the feed line was about 200 lb. and the air compression would furnish only 65 lb. A displacement rig was therefore installed, the material for which was mostly obtained from the scrap pile. This consisted of another section of 8-in. pipe *E* set up in a vertical position but about 10 ft. lower than the air chamber. A ½-in. cock was placed at both top and bottom and ½-in. pipes *F* and *G* connecting the top and bottom of the two chambers, with valves placed near the bottom chamber. The air in the latter was displaced by the water which came down the ½-in. pipes until the pressures were equalized, and then the compressed air ascended in a few seconds to the upper chamber. A few operations sufficed to fill the latter three-quarters full of compressed air, and a few minutes' daily attention was all that was required to keep it there. All pulsation in the feed lines disappeared, and the air chamber and its home-made filling device were retained in service even after the centrifugal pump was again placed in commission.

Hawkesbury, Ont., Canada. G. B. SOMER.

Shaft Alignment

The article in the June 10 issue, by Mr. Dahlstrand, on the subject of shaft alignment and its importance, was particularly timely and instructive, inasmuch as this question is one that does not receive from the average engineer the attention that it warrants. Mr. Dahlstrand states that a flexible coupling will not take care of misalignment, but that it will take care of movement in an axial direction. While most so-called flexible couplings will allow an axial movement of one-half relative to the other when running at no load, when load is applied we are confronted with a totally different proposition. In some designs the coupling not only does not respond to longitudinal movement, but actually creates an end thrust in itself, tending to force the two halves apart.

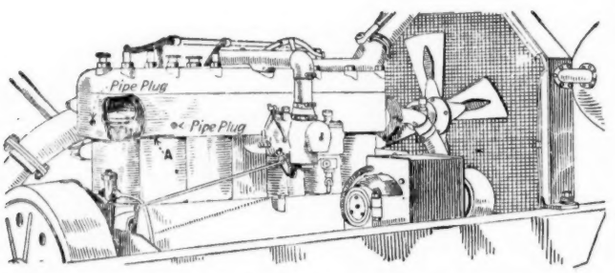
Of course it is appreciated that a carefully machined and well-designed coupling operating under forced lubrication will allow comparatively free movement endwise, but for small work such as in turbine-driven auxiliaries it is poor engineering to rely upon free endwise motion with the standard type of coupling commonly used for this work. One other criticism that presents itself is the low estimate made by Mr. Dahlstrand of the percentage of troubles that are due to misalignment. I made a very careful investigation of this some time ago, regarding troubles covering several hundred machines and my estimate is that this percentage should be nearer 80 to 90 per cent. and I believe this percentage will be confirmed by several of the pump makers who have had experience with this class of apparatus.

If, as Mr. Dahlstrand points out (and he expresses the opinion of most engineers today), the flexible coupling will not take care of misalignment, then why go to the complication of same and why not have a solid coupling with the elimination of at least one of the bearings? For small auxiliary work more than two bearings on the average equipments are unnecessary. W. J. A. LONDON.

Springfield, Mass.

Repairing a Cracked Water Jacket

The article entitled, "Repairing a Cracked Water Jacket," appearing a short time ago in an issue of *Power*, prompts me to explain the manner in which a somewhat similar crack was repaired by means apparently more simple than those described in the article under discussion. Nothing original is claimed for the method used, although, to my knowledge, it had never been used before under similar circumstances. A couple of acquaintances of mine have



ENGINE SHOWING POSITION OF WATER-JACKET CRACK

since used the method and it proved successful in both cases.

This particular engine was in a car. As soon as cold weather set in, for fear of a freeze-up the jacket was thoroughly drained. In order to drain this particular type of engine, it is necessary to open the pet-cock underneath the pump and also to remove two small pipe plugs on the opposite side of the casting, as shown in the sketch. To insure a thorough draining, the pet-cock was opened, the two plugs removed, the left front wheel of the car jacked up several inches; all according to the instructions for draining this type of engine. The car was left in the garage for about one week, during which there were two days of zero weather. Upon the return of warmer weather it was decided to drive the car. The plugs were therefore returned to their respective places, the pet-cock closed underneath the pump, and the jacket filled with water.

A very bad leak was immediately noticed at the point *A*. The crack was about three inches long and in a somewhat inaccessible place. The jacket was drained, and an examination was made to discover the cause of the crack.

A wire was introduced in one pipe-plug hole as a feeler, and there appeared to be a bank of sand or some obstruction in the water chamber. By poking this wire in each of the plug holes and then flushing out the water jacket nearly a cupful of what apparently was coarse sand was obtained. The explanation that presented itself for the freezing and bursting of this jacket was that this sand had never been thoroughly cleaned out and that it had retained sufficient water so that upon freezing its expansion broke the casting.

To make the repair a small three-cornered file with the end broken off was used to clean the paint from the casting adjacent to the crack and to clean out the edges of the crack. A few cents' worth of sal ammoniac powder was then mixed with very fine cast-iron filings in an indiscriminate proportion. The water jacket was then filled sufficiently to permit water to trickle through the crack, after which the jacket was drained. This was done in order to wet the surface of the crack. The mixture of sal ammoniac and iron filings was then rubbed in the crack by means of the thumb and finger, working the mixture in as much as possible and finally leaving on as much as would adhere conveniently. It was hoped that the moisture in this crack would naturally, by capillary attraction, gradually work this solution of sal ammoniac into the crack to the full extent of the thickness of the casting. The car was allowed to stand for about four days, and then the superfluous sal ammoniac on the outside was scraped off. Black machinery enamel was used to cover over the rusted appearance of the crack as well as to prevent any further outside rusting. The jacket was then filled, and up to the present writing, which is more than a year since the job was done, no leakage has appeared.

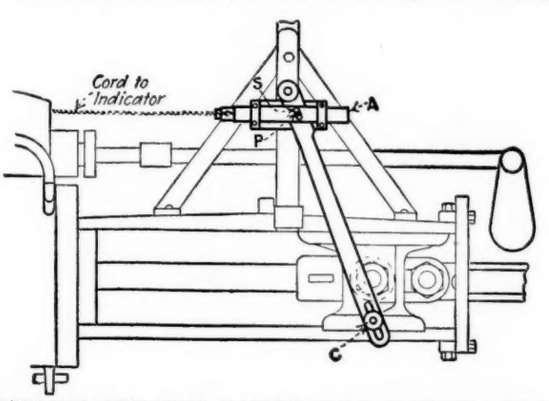
The action which took place was of course merely a rusting-in process. As there is very little pressure in the water jacket at any time, there is no reason why this type of repair is not suited to any such break, and it is a convenient as well as an inexpensive method, as compared with taking the engine out and having a proper weld made by use of the oxyacetylene torch, which is an expensive method as well as one which is likely to cause a distortion in some part of the engine unless the job is done by an experienced man and extreme care used in heating the entire cylinder block.

There is no reason why the foregoing method should not be successful in cases of a similar nature if sufficient time is allowed for the rusting-in process.

Groton, N. Y. C. D. CORWIN.

Altering a Reducing Motion

The inaccuracy of a reducing motion having a slot in the lower end of the lever, referred to on page 988, June 24 issue of *Power*, is eliminated by the arrange-



CORRECT REDUCING MOTION WITH SLOTTED LEVER

ment shown in the sketch. *A* is a sliding piece with pin *P* moved by a second slot *S* situated higher up in the same lever, as illustrated. Horizontal motion of the pin and sliding piece *A* is always in proportion to movement of the pin *C* in the crosshead. O. TANFEU.

Jamaica, B. W. I.

[This type of reducing gear is perfect only so long as there is no lost motion between the pins and the sides of the slots, and the slide *A* is guided parallel with the motion of the crosshead and with the cord to the indicator taken off parallel with the stroke.—Editor.]

Inquiries of General Interest

Eccentric Ahead or Behind Crank—When is the crank of an engine said to follow the eccentric or the eccentric to follow the crank? H. C. R.

The angle that an eccentric makes with the crank is indicated by the position of the "high side" of the eccentric with reference to the crank. The crank is said to follow the eccentric or the eccentric to be ahead of the crank, when the eccentric is less than 180 deg. ahead, measuring in the direction of rotation of the shaft. The eccentric is said to follow the crank or the crank to be ahead of the eccentric when the crank is less than 180 deg. ahead of the eccentric, measuring in the direction of rotation.

Boiler Corrosion from Feeding Heating Returns—We are troubled with pitting of the front lower sheet of our horizontal return-tubular boiler and believe it may be due to feeding the condensation returned from an exhaust steam-heating apparatus, as the corrosion does not seem to continue after the heating season is over. How can the trouble be cured? S. K.

Corrosion from refeeding condensate might be more rapid because the water is purer, or from free acid due to adulterants in the engine cylinder oil which find their way into the boiler, but in either case all parts of the water space would be affected. If the corrosion is mainly confined to pitting of the fire sheets, they may have been overheated from presence of oil carried over from the exhaust, and once burnt, their corrosion would proceed more rapidly. Better means should be employed for removing oil from the exhaust and condensate before refeeding. Use engine cylinder oil sparingly, wash the boiler more frequently and if the boiler has to be forced, do not feed the return water from the exhaust-steam heating system.

Saturated and Superheated Steam—What is meant by saturated and superheated steam? H. M. C.

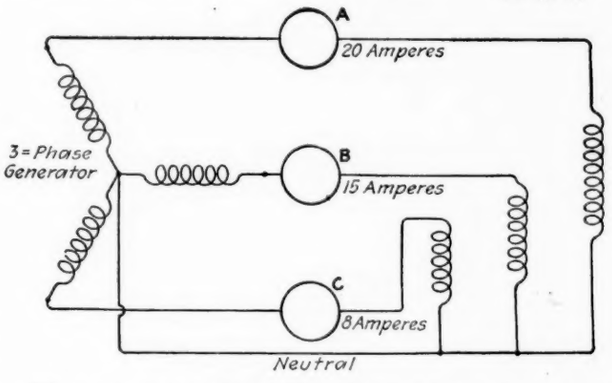
Steam that is at the evaporation temperature corresponding to its pressure is said to be "saturated steam." When steam formed in a boiler rises from the surface of the water, it is saturated, and will remain so as long as it is in contact with the water, and so long as the steam is in a boiler in close communication with the water it cannot be other than saturated, for any attempt to heat the steam to a higher temperature will fail, as the heat will be transmitted to the water and cause further evaporation. Saturated steam may be perfectly dry, or it may be "wet" saturated steam containing suspended particles of water, just as water is suspended in the atmosphere during a fog. Whenever steam is mentioned without qualification, it is understood to be dry saturated steam. Superheated steam is steam whose temperature is higher than the evaporation temperature corresponding with its pressure, and to effect superheating of saturated steam it must be heated away from water to a higher temperature than the temperature of saturated steam of the same pressure and without changing the pressure.

Setting Slide Valve Without Uncovering—How can the valve of a slide valve engine be set without uncovering the valve chest? W. R.

The valve can be set approximately without uncovering the valve, from judgment of the equality of flow of steam from the cylinder waste cocks for determining when the steam ports are nearly covered by the admission edges of the valve. With the cylinder waste cocks wide open and the throttle valve opened only a very little, place the crosshead so the piston will be at a point of the stroke first in one end and then in the other end of the cylinder to obtain a very small but apparently equal discharge of steam from the waste cocks, and for each position, make a mark on the valve rod at the gland of its stuffing-box and locate a mark midway between those marks. Then turn the engine over slowly and mark the valve rod in the same manner when it is farthest in and out of the stuffing-box and locate a mark midway between these marks. If the first and second middle marks do not agree, it is because the valve travels more to one side than to the other side of the center of the ports. If the mark that represents the middle of the valve travel falls on the steam chest side of the first middle mark, the distance between the marks shows the amount that the valve rod is too long, or falling on the crank side, the distance shows the amount the rod is too short for giving symmetrical travel of the valve, and the difference should be rectified by adjustment of the length of the valve rod or of the eccentric rod. After thus equalizing the valve travel, place the engine on a center and turn the eccentric on the shaft in the direction of rotation of the engine and set the eccentric on the shaft when discharge of steam from the waste cock indicates that the valve is beginning to open and determine whether the same opening of the valve has been obtained when the engine is placed on the other center.

Current in the Neutral of a Three-Phase System—Three ammeters, *A*, *B* and *C*, are connected in a four-wire three-phase system and read 20, 15 and 8 amperes respectively, as shown in the figure. What is the current in the neutral conductor if the power factor of each load is unity?

A. R. C.



When the power factor of the system is unity, the current in the neutral of a four-wire three-phase system is always equal to

$$I_N = \sqrt{(I_A - I_B)^2 + (I_B - I_C)^2 + 2\,(I_A - I_B) \times (I_B - I_C) \times \cos 60\ deg.}$$

where I_A, the reading of ammeter *A*, equals 20 amperes; I_B, the reading of ammeter *B*, equals 15 amperes; and I_C, the reading of ammeter *C*, equals 8 amperes.

Then,

$$I_N = \sqrt{(20 - 15)^2 + (15 - 8)^2 + 2\,(20 - 15) \times (15 - 8) \times 0.5}$$

$$= \sqrt{5^2 + 7^2 + (2 \times 5 \times 7 \times 0.5)} = 10.44 \text{ amperes.}$$

It should be remembered that to use the arrangement of symbols in the formula it is necessary that I_A have the highest value, I_B the intermediate value and I_C the smallest value.

[Correspondents sending us inquiries should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications and for the inquiries to receive attention.—Editor.]

Dirt in Coal*

In different localities, and frequently in the same locality under different conditions of mining and preparation, the ash content in coal varies widely. The normal amount of ash may be considered as that found in the face sample of the seam proper; the excess ash is that which is added to the coal from the roof or bottom in the process of mining and which is not eliminated before the coal leaves the mine. Lump coal made over a 1¼-in. screen usually shows the normal percentage of ash, while the 1¼-in. screenings in most cases show 1½ times the percentage of ash contained in the lump.

In screenings the ash content can be reduced nearly to that of the screened lump by the use of a jig gravity washer, with an ample water supply and a convenient place to deposit the refuse. However, the washing of screenings has been considered too expensive while the price of all coal was low, but since prices have increased 60 per cent. and more, and will probably remain so, it may be profitable to eliminate the excess ash by washing in the vicinity of the mines, thereby saving the long haul of inert material to points where the coal is finally consumed, the cost of which would be about six mills per ton mile. The following data giving ash and B.t.u. content of coal from a bituminous mine in the Central West district illustrates how the ash in screenings can be reduced by washing:

COAL FROM ONE MINE IN CENTRAL WEST

	Ash, Per Cent.	B.t.u.
Dry or unwashed screenings	22.61	8,895
Washed screenings	14.05	10,085
Lump	12.39	10,499

In mine run and prepared sizes made over 1¼-in. screen, the excess ash can be removed easily by hand by the miner at the working face when loading into the mine cars, or by having men or boys working on picking tables or belts while the coal is passing to the railroad car.

This work can be looked after by a regularly assigned fuel inspector. The railroad employing the speaker used a system of close inspection with suggestions to the mine superintendents on the ground while the coal is being loaded. As a result of this effort, the impurities removable by hand-picking and based on actual carload tests have been reduced from an average of 2.733 per cent. in the year 1911 to an average of 1.535 per cent. This, applied to a consumption of 4,000,000 tons of coal used annually, represents 47,920 tons less ash, which would have required the use of 958 fifty-ton cars to move it. The transportation cost of moving this excess ash an average distance of 266 miles, based on an "out of pocket" cost of five mills per net ton mile, equaled $63,733.60 per annum. This, however, was but the lesser saving.

TABLE I. ANALYSES OF COALS

Test Number	Moisture, Per Cent.	Volatile Matter, Per Cent.	Fixed Carbon, Per Cent.	Ash, Per Cent.	Sulphur, Per Cent.	B.t.u.	Clinker
1	3.37	31.31	55.19	9.63	0.64	12,325	No
2	6.02	30.00	53.50	10.30	1.30	12,136	No
3	4.61	31.35	54.05	10.00	1.19	12,368	No
4	2.92	33.10	51.25	12.73	2.96	12,389	Yes
5	4.99	39.22	43.99	11.80	4.43	11,768	Slightly
6	3.41	37.12	45.62	13.85	4.02	11,842	Yes
7	5.13	37.70	44.31	12.80	4.52	11,693	Yes
8	2.86	36.04	43.14	17.96	4.58	11,124	Yes
9	8.49	34.87	48.16	8.48	1.47	12,251	No
10	4.68	38.59	44.24	12.49	4.50	11,921	Yes

Taking the established estimate of increase in efficiency of 1½ per cent. for each reduction of 1 per cent. in ash, the saving from this source (that is, increased evaporative efficiency) with coal at a delivered price of $3.68 per ton, equaled $264,518.40, or a total saving of $328,252 per annum. What the measure of the economies following from reduced engine failures and reduction in engine house expenses amounted to is difficult of computation.

Effective combustion of coal depends largely on the nature and percentage of impurities it contains, especially so if the ash has a tendency to clinker, which is dependent on the percentage of silica, iron and lime in its composition. Tables I and II give analyses of coal and ash used in ten burning tests from ten different mines in Illinois and Indiana.

By referring to the column showing the clinkering and nonclinkering coals and then making a review of the ash table, it will be observed that the coals with nonclinkering ash are low in both sulphur and lime. In burning they did not clinker in a dazzling white fire of an approximate temperature of 2900 deg. F., while the ash in the clinkering coals fused at a firebox temperature of approximately 2200 deg. F., which indicates clearly that when the sulphur and lime content exist in high proportion to the silica, iron and aluminum oxides, it is the direct cause of the ash fusing at the lower temperature.

TABLE II. ANALYSES OF ASH

Test Number	Sulphur (S) Per Cent.	Silica Oxide (SiO_2) Per Cent.	Iron Oxide (Fe_2O_3) Per Cent.	Aluminum Oxide (Al_2O_3) Per Cent.	Calcium Oxide (Lime) (CaO) Per Cent.	Magnesium Oxide (MgO) Per Cent.	Color of Ash
1	0.64	59.0	3.1	31.0	5.6	1.3	White
2	1.30	55.2	8.3	26.6	7.3	1.3	White
3	1.19	56.1	8.1	27.2	5.4	0.9	Light gray
4	2.96	45.4	25.3	16.9	11.6	0.8	Reddish gray
5	4.43	49.1	32.2	13.5	4.5	1.4	Reddish gray
6	4.02	35.1	22.4	10.2	30.8	1.5	Reddish gray
7	4.52	43.3	24.1	9.0	19.9	1.2	Reddish gray
8	4.58	44.8	20.3	18.6	16.4	1.5	Reddish gray
9	1.47	45.8	20.2	28.3	5.4	0.0	White
10	4.50	27.1	52.3	14.1	4.4	1.2	Dark gray
Fusing tem. deg. F.	239	3227	2840	3416	3452	3882	.....

From the bottom line of Table II, giving the fusing temperature of the sulphur and the different oxides, it will be seen that by taking each element separately the fusing point is at a higher temperature than usually obtains in the furnace of a boiler. However, by combining these elements in proper proportion with the sulphur, fusion at a much lower temperature will take place.

In these ten experiments the conditions as to draft, etc., were identical. It has been observed since, however, that the coals containing the clinkering ash will give better results both as to combustion and reduction of slag in the ash by increasing the draft. More air through the fuel bed has a tendency to keep the temperature of the fire below the fusing point of the ash. Hence it is good policy to assign clinkering coals to a lower class of service.

*Abstract of paper read before the International Railway Fuel Association, Chicago, May 19-22, by L. J. Joffray, general fuel inspector of the Illinois Central Railroad.

Engineering Societies Pass Resolutions on Andrew Carnegie

Andrew Carnegie's death August 11, 1919, at Lenox Massachusetts, brought to its close a career which greatly advanced all the engineering arts and sciences. By the introduction into the United States of the Bessemer process for the production of steel and by the establishment and development of steel plants, which became the greatest in the world, he made available for engineers the most useful modern material for engineering construction. In the successful conduct of many industrial enterprises, he amassed great wealth, the possession of which he came to regard with deep seriousness as a public trusteeship. He devoted himself to the distribution of large portions of his fortune to projects for the benefit of mankind. He distributed his wealth not only in many directions, but also with the exercise of great wisdom based on careful investigation. His munificence provided large funds for the building of a home for the great national engineering societies and many associate societies. He was an honorary member of the American Institute of Mining and Metallurgical Engineers and American Society of Mechanical Engineers. He was personally known and loved by many engineers. In view of these facts, be it

Resolved, That the American Societies of Civil, Mining, Metallurgical, Mechanical and Electrical Engineers, the United Engineering Society and the Engineers' Club, herein express to the family of Mr. Carnegie and record their sincere appreciation of the great contributions of Andrew Carnegie to the advancement of engineering, and of his friendly assistance in making possible beautiful homes for the Engineering Societies and the Engineers' Club, thus fostering the spirit of unity in the profession.

A. I. E. E. Development Committee Presents Reports

At a meeting of the board of directors of the American Institute of Electrical Engineers, held Aug. 12th, 1919, a resolution was adopted, that the report of the Committee on Development be received, that the recommendations in the report of the Committee on Development, dated Aug. 12, 1919, be approved in principle and that the president refer the various parts of the report to qualified committees, either existing or special, with the request that these committees formulate definite plans of procedure with estimates of expense involved, for bringing into effect such changes in present practice as the committees deem desirable; the Committee on Development to be continued, with particular reference to the consideration of the institute's participation in joint activities with various other engineering and technical organizations.

The report of the Committee on Development as received by the board of directors Aug. 12 follows closely the general outline of the committee's recommendation published on page 296 of Aug. 12 issue of *Power*. Following are the parts of the report that deal with the change in the *Proceedings* and the holding of an Engineering Congress.

There is an almost unanimous view that the *Proceedings* do not seem sufficient to interest the membership at large, and the suggestions of a remedy cover a wide range of possibilities. The value of the class of papers which heretofore have been published in the *Proceedings* as representing advances in the art and constitute a record of progress is appreciated and it is insisted that the high standard of the institute should be maintained but it is believed that this view is not inconsistent with a recognition of the rights of 90 per cent or perhaps 95 per cent of the total membership who are concerned with the day to day engineering problems and with the personal side of engineering relationships. It is believed that if the *Proceedings* can be properly expanded that publication will serve better to both bind the present membership closer together and furnish an added incentive for engineers not already members to join. The Development Committee has devoted a great deal of time to discussions of this matter but feels that with the recommendations of the various sections and the stenographic report of the Lake Placid meetings to be considered further study should be given to this matter. They, therefore, submit the following recommendations, to wit:

That the Publication Committee be asked to consider and recommend to the board improvements in the present plan of publishing the *Proceedings* and the *Transactions* and of printing and distributing copies of institute, sections and branch papers.

That in dealing with these questions the Publication Committee consider:

A. Enlarging the editorial and executive publication staff for the purpose of expanding the *Proceedings* to contain additional live matter of interest and value to the membership as a whole without giving less importance to the principal activities of the institute, that is, the promotion of the fundamental advance in the art and the encouragement of original investigation in the field of electricity.

B. Publishing all institute papers and occasional papers of unusual broad general interest and value from sections or from other sources; publishing a set of abstracts of every paper presented to every section so that each month there will be a complete record of this class of institute activity.

C. Eliminating as far as may be feasible the duplication of expense now incurred by twice publishing the papers heretofore distributed (in both the *Proceedings* and the *Transactions*) but without depriving the membership of the *Transactions* in some form.

D. Publishing discussions in the *Proceedings*.

E. Endeavoring to increase the revenue producing capacity of the *Proceedings* by expanding its advertising policy and if necessary changing its page dimensions.

F. Printing pamphlet copies of some or all section and perhaps branch papers and economizing on the cost of printing institute and such section and branch papers by limiting their quantity and free distribution while making them available for the membership.

That there be inaugurated the custom of periodically holding an Engineering Congress, the delegates to which should be selected from all parts of the country under a plan to be developed for suitable representation, this congress to consider and take action on such matters of general interest to engineers and to the public as may merit its attention and as have been previously advertised, for a sufficient length of time, to permit locals everywhere to give them consideration and when possible to send instructed delegates.

The second reason, namely, a possible modification of the engineering curricula of our technical schools and colleges while perhaps of underlying and fundamental importance not only did not have the general consideration of many of the sections in their local deliberations but was nearly crowded off the Lake Placid program by the press of other matters. It was, however, the unanimous view of the members attending the sessions at Lake Placid that this matter should receive early and thorough consideration by the institute, and the following preamble and resolution was there presented and adopted:

"As the individual engineer cannot look for greater public recognition or individual advancement than his training and fitness warrant,

And, in the belief that the bigger development of the profession consists in broader social and public service by publicily-minded engineers,

Recognizing that on the one hand young engineers are employed for too long a period at work which does not stress their capabilities and, on the other, that the demands of industry for ever-increasing numbers of technicians must be supplied,

And having in mind the excellent precedents established by the medical and legal professions,

This committee would welcome the establishment at the earliest date practicable of a normal six years' collegiate course in engineering, two years of which at the least should be devoted to training in the humane arts and sciences including, for example, Political Science, Economics, History and General Letters; the last four years being devoted to sound training in the sciences and in only the fundamentals of diversified engineering.

With or prior to such a development we would endorse a program for the marked extension of vocational training in the industrial centers in order that the needs of industry may be met.

To the accomplishment of these ends this committee requests the appointment of representatives to serve on a joint committee of engineering organizations to promote such a national educational program as shall provide for the future necessities of the engineering profession consistent with the needs of society."

N. E. L. A. New England Section to Hold Eleventh Annual Convention

From Sept. 22 to Sept. 24 the New England Section of the National Electric Light Association will hold its 11th annual convention at New London, Conn., with the Hotel Griswold as headquarters. In the tentative program that has been arranged is included the following:

Monday, Sept. 22, 10 a.m.—President's address, George B. Leland; treasurer's report, Bowen Tufts; secretary's report, Miss O. A. Bursiel. Standing Committee reports: "Advertising and Publicity," L. D. Gibbs, chairman; "Accident Prevention," H. W. Moses, chairman; Membership, Merle R. Griffith, chairman; "The Purchase of Coal," by Perry Barker; "High-Power Switching Apparatus Used in Connection with Large Systems," by Fred L. Hunt.

Monday, Sept. 22, 2 p.m.—Session in charge of and assisted by members under forty years of age; chairman, F. A. Belden; assistant chairman, Leavitt L. Edgar. (Topics not yet announced.)

Tuesday, Sept. 23, 10 a.m.—Commercial session; Com-

mercial Section Committeee report, C. E. Greenwood, chairman. (To be followed by discussion of commercial subjects.)

Tuesday, Sept. 23, 2 p.m.—Commercial session—"The Use of the Electric Range in a Small City," by E. F. Putnam; "Electric Ranges and Water Heating," by M. C. Osborn.

Tuesday, Sept. 23, 7 p.m.—Dinner. This occasion will be similar in dignity and importance to previous banquets. Dinner will be followed by public policy session—A. B. Lisle, chairman Public Policy Committee; address by R. H. Ballard, president National Electric Light Association; "Municipal Ownership and Socialism," by F. G. R. Gordon. Representatives of New England public service commissions will be guests.

Wednesday, Sept. 24, 10 a.m.—"High-Tension Cables," by Wallace S. Clark, followed by discussion by operating men; "The Control and Improvement of Power Factor," by Nicholas Stahl, followed by discussion by operating men; "Planning for Power as Applied to New England," by Prof. Charles F. Scott.

Wednesday, Sept. 24, 2 p.m.—Accounting Section Committee report, Frederick E. Webster, chairman; Electric Vehicle Committee report, Day Baker, chairman; annual meeting class A members; election of officers.

Government Needs Skilled Men

The new naval ordnance plant at South Charleston, W. Va., is now about to begin the manufacture of armor plate, and forgings for guns of large caliber, entirely new lines of work for Government plants. The South Charleston plant is a $19,000,000 enterprise occupying more than 200 acres of land. It will be ready for making armor and heavy forgings as soon as the assembling of the necessary working force can be completed. Disturbed labor conditions incident to the war have been responsible for a delay in getting this work started. The new plant is equipped with every modern appliance for the manufacture of its specialties, and will turn out annually 50,000 tons of armor plate, guns, projectiles and miscellaneous ordnance forgings.

Engineers, metallurgists and mill and machine-shop men will be interested in the positions which are to be filled in the supervisory and subordinate forces. Detailed information and application blanks may be obtained from the United States Civil Service Commission, Washington, D. C., or from the secretary of the local board of civil service examiners at the post office or custom house in any of 3000 cities. Journeyman workmen and helpers should apply direct to the labor board at the South Charleston plant.

Transportation to Huntington Convention of the N. A. S. E

The transportation committee of the New York and New Jersey delegation to the national convention of the National Association of Stationary Engineers, Huntington, W. Va., Sept. 8 to 13, announces transportation arrangements.

Leave	Pennsylvania Station	3.34 p.m.,	Sunday,	Sept. 7
"	Manhattan Transfer	3.46 "	"	"
"	Market St., Newark	3.57 "	"	"
"	Elizabeth	4.07 "	"	"
"	Trenton	4.58 "	"	"
"	West Philadelphia	5.47 "	"	"
Arrive	Washington	9.15 "	"	"
"	Huntington	1.20 p.m.,	Monday,	Sept. 8

The fare is $19.98, tax $1.60, lower berth $3.50, tax $0.28, total $25.36; upper berth $2.80, tax $0.22; drawing room $13.00, tax $1.04.

The delegates will have at least three cars to themselves, and will be joined by the New England delegation in New York or Washington. Arrangements have been made for delegates to meet at window No. 18, Friday, Sept. 5, 8 to 9.30 p.m., to pay for and receive tickets. J. D. Taylor, chairman, Museum of Art, 5th Ave. at 82d St., will make reservations upon receipt of full amount, and will hold them until train time for those who cannot get to the ticket office.

New Publications

INDUCTION COILS. By Prof. F. E. Austin. Published by the author, Hanover, N. H. Cloth; 5¼ x 8¼ in.; 64 pages; 45 illustrations. Price, $1.

In this little book the induction coil is treated of in theory and practice. The author has aimed to present the explanations of fundamental principles so as to enable anyone to construct induction coils to meet a variety of demands and specific requirements. The book may be divided into eleven parts, dealing with: The generation of an electromotive force by magnetic induction; magnetic circuits; primary and secondary circuits; mathematical theory of operation of induction coils; structural features; interrupters; condensers; specification for different sizes of coils; spark coils; Tesla coils; choke coils. Those interested in the construction and application of induction coils will find this book to contain considerable valuable information applicable to this class of work.

THE CONSTRUCTION OF GRAPHIC CHARTS. By John B. Peddle, Professor of Machine Design, Rose Polytechnic Institute. Published by the McGraw-Hill Co., Inc., New York City. Cloth; 6 x 9¼ in.; 155 pages; illustrated.

The calculating chart, or nomogram, as a means of application of formulas under different conditions has been growing in popularity with the more progressive engineer to a great extent in recent years. That such use has not been more general in the past, is due in all probability to the fact that many engineers have considered these chart forms as being of such complex mathematical nature as to be beyond the comprehension of the average operator. For the benefit of those who are rusty in mathematics an effort has been made to simplify the treatment and to illustrate in detail the various chart forms described. Beginning in Chapter 1 the simplest form of chart—those plotted on rectangular coördinates—are fully described and illustrated, followed in Chapter 2 by the alinement chart and in order the problems of charts involving three or more variables, the haxagonal index chart, proportional charts, empirical equations and the stereographic charts and solid models. The last chapter involves the principles and application of variables. The book seems admirably suited to its purpose—to acquaint the engineer with the underlying principles of the graphic chart and to instruct him in the methods of constructing such charts as might be suited to his individual needs.

Engineering Affairs

The Eccentric Firemen, L. U. No. 56, held its athletic games and picnic at Celtic Park, Long Island City, Sunday afternoon, Aug. 17. The usual large crowd witnessed the feats of the firemen.

The Association of Edison Illuminating Companies will hold its thirty-eighth convention—the first the association has held in three years—at the Griswold, Eastern Point, New London, Conn., Sept. 15-18. Among the papers to be presented will be one on "Fuel," with special reference to pulverized coal and fuel oil.

The American Institute of Electrical Engineers will hold its Pacific Coast convention this year at Los Angeles, Calif., Sept. 18 to 20 inclusive. The convention will be held under the auspices of the local section, and it is expected that John F. Fisken, one of the institute's vice-presidents will preside at the various meetings. A tentative program has been worked up and includes the following papers: "Order and Amplitude of Harmonics in Voltage-Wave Forms with Indicating Instruments," by Leslie F. Curtis; "Theory of Probabilities Applied to Failures of Suspension Insulators," by L. M. Klauber; "Predetermination of Synchronous Phase-Modifier Performance," by Hubert V. Carpenter; "Operating Features of a 1000-Mile, 220,000-volt Transmission Line," by R. W. Sorrenson, H. H. Cox and G. E. Armstrong.

Personals

C. Lincoln Smith, who in the past has been sales engineer for the Sanford Riley Stoker Co. and the Murphy Iron Works in the Chicago territory has been transferred to the company's Pittsburgh office.

R. S. Rowe, formerly western representative of the Lunkenheimer Co., with offices in Denver and Minneapolis, has been appointed export manager with office in New York City.

W. E. Symons and R. Sanford Riley have been appointed by the Council of the American Society of Mechanical Engineers to represent the society in the celebration of the centenary of the death of James Watt, at Birmingham, England.

Byron F. Stowell, for many years connected with the Hendee Manufacturing Co., Springfield, Mass., as master mechanic and mechanical engineer, has resigned to accept a position with the Napier Saw Works, Inc., of same city.

Obituary

William V. R. Coon, for many years a member of Ohio No. 37, N. A. S. E., of Dayton, died of cancer of the stomach on July 26. Mr. Coon was one of the best and most favorably known engineers in this part of the country. As a delegate from Ohio No. 37, he had attended nearly all National conventions for the past 20 years. He served as secretary of the State Association for three years, and as corresponding secretary of No. 37 for fifteen years. He was also affiliated with the Craftsmen, the Woodmen, the Junior Order of American Mechanics, the Sons of Veterans, and was a 32rd degree Mason. For many years he was chief engineer of Lowe Brothers steam plant; later he was state examiner of engineers for three years, and for a like period he was chief engineer of the Dayton City Water Works.

THE COAL MARKET

BOSTON—Current prices per gross ton f.o.b. New York loading ports:

Anthracite

	Company Coal
Egg	$7.80@7.95
Stove	7.95@8.15
Chestnut	8.05@8.35

Bituminous

	Clearfields	Cambrias and Somersets
F. o. b. mines, net tons	$2.60@3.10	$3.00@3.60
F. o. b. Philadelphia, gross tons	4.79@5.35	5.20@5.80
F. o. b. New York, gross tons	5.10@5.70	5.50@6.20
Alongside Boston (water coal), gross tons	6.85@7.35	7.10@7.85

Georges Creek is quoted at $3.70 per net ton, f. o. b. mines.

Pocahontas and New River are being quoted at $6.25@6.60 per gross ton f.o.b. Norfolk and Newport News, Va., in response to export demand. There are practically no sales for coastwise shipment.

NEW YORK—Current quotations, White Ash, per gross tons, f.o.b. Tidewater, at the lower ports* are as follows:

	Mine	Tidewater		Mine	Tidewater
Broken	$5.95	$7.80	Pea	$5.20	$6.95
Egg	6.25	8.10	Buckwheat	3.40	5.15
Stove	6.50	8.35	Rice	2.75	4.50
Chestnut	6.60	8.45	Barley	2.25	4.00

Bituminous

Current quotations on spot coal, net tons, at the mines average about as follows:

	Spot
South Fork (best)	$3.25@3.50
Cambria (best)	3.00@3.25
Cambria (ordinary)	2.65@2.90
Clearfield (best)	3.00@3.25
Clearfield (ordinary)	2.70@3.00
Reynoldsville	2.70@2.90
Quemahoning	3.10@3.25
Somerset (best)	3.00@3.25
Somerset (poor)	2.65@2.75
Western Maryland	2.50@2.75
Fairmont	2.10@2.35
Latrobe	2.60@2.65
Greensburg	2.50@2.60
Westmoreland ¾ in.	2.75@2.90
Westmoreland run-of-mine	2.50@2.60

PHILADELPHIA—The price per gross ton f.o.b. cars at mines for line shipment and f.o.b. Port Richmond for tide are as follows:

	Line	Tide		Anthracite Line	Anthracite Tide
Broken	$5.95	$7.80	Buckwheat	$3.40	$4.45
Egg	6.25	8.10	Rice	2.75	3.65
Stove	6.50	8.35	Boiler	2.50	3.50
Nut	6.60	8.45	Barley	2.25	3.15
Pea	5.20	6.80			

CHICAGO—Current prices per ton for Illinois and Indiana coal are as follows:

Illinois

Williamson, Saline and Williamson Counties	Southern Illinois F.o.b. Mines	Northern Illinois F.o.b. Mines
Prepared sizes	$2.55@$2.75	$3.25
Mine-run	2.35@ 2.50	3.00
Screenings	1.40@ 1.60	2.75

BIRMINGHAM—Current prices per net ton f.o.b. mines are as follows:

	Mine-Run	Prepared	Slack and Screenings
Big seam	$2.45	$2.75	$2.40
Black Creek and Cahaba	3.45	3.75	3.05
Jagger - Pratt Corona	2.85	3.05	2.45
Blacksmith	....	5.25	.....

Domestic quotations, slightly increased, are as follows:

	Lump and Nut
Black Creek and Cahaba	3.95@$4.60
Corona	3.50
Jagger	3.50
Montvallo	5.00

ST. LOUIS—The prewailing circular per net ton f.o.b. mines is as follows:

Franklin County	Mt. Olive and Staunton	Standard
Prepared sizes (lump, egg, nut, etc.)	$2.85*@3.05 $2.55	$2.25@2.50
Mine run	2.10*@2.35 2.35	1.60@1.70
Screenings	1.50*@2.20 2.05	.90@1.00

* Indicates prices on independent coal.

Williamson-Franklin rate to St. Louis is $1.07½; other rat s $0.92½.

New Construction

PROPOSED WORK

N. H., Portsmouth—Spec. No. 4017—The Bureau of Yards & Docks, Navy Department, Washington, D. C., plans to install a 1000 k.w. turbo-generator, here. Estimated cost, $17,000.

Mass., Pittsfield—The city received low bid for the construction of a school house on Wahconah St. in Pontoonac District from E. C. Corison & Co., 310 Main St., Springfield. A heating system will be installed in same. Total estimated cost, $129,600.

R. I., North Smithfield—The Andrews Mills Co., Branch Village, plans to install 2600 ft. c. i. waterpiping in its proposed 40 x 40 ft. reinforced concrete pump house, and a 250 hp. wheel in its proposed concrete power house. Work will be done by day labor. Jenks & Ballou, 1035 Grosvenor Bldg., Providence, Engr.

Conn., Bridgeport—The Bridgeport Brass Co., Grand St., will build a 1 story, 150 x 220 ft. addition to its casting shop on Grand St. Electric power to operate crane will be installed in same. Is in the market for Shepherd electric crane. Total estimated cost, $150,000. The H. M. Lane Co., 701 Owen Bldg., Detroit, Engr.

Conn., Hartford—The American School for the Deaf, 65 Garden St., will soon award the contract for the construction of 3 buildings for a school. A steam heating system will be installed in same. Total estimated cost, $500,000. Boring and Tilton, 52 Vanderbilt Ave., New York City, Engr.

Conn., Litchfield — The St. Michael's Protestant Episcopal Society will soon receive bids for the construction of a church on Main St. A steam heating system will be installed in same. Total estimated cost, $100,000. Rossiter & Muller, 15 West 38th St., New York City, Arch.

Conn., Mystic—The Packer Tar Soap Co., Lincoln Ave., plans to build a 1 story storage building, a 1 story factory, and a 25 x 30 ft. power house. A steam heating system will be installed in same. Total estimated cost, $40,000. Bilderbeck & Langdon, Inc., Barrows Bldg., New London, Engr.

Conn., New Haven—J. A. Wetmore, Supervising Arch., Treasury Dept., Wash., D. C., will receive bids Sept. 12, for a motor driven triplex pump for the U. S. Post-Office here.

N. Y., Albany—The Kelley Dennin Co. plans to build garage, machine shop and salesroom on Broadway, to be 1 story, 150 x 150 ft. with 2 wings. A steam heating plant will be installed in same. Total estimated cost, $150,000. A. E. Lew, Vice Pres.

N. Y., Brooklyn—Magid, Katzman & Strober, 58 Boerum St., plan to construct a 1 story, 100 x 185 ft., warehouse garage and workshop on Jefferson St., Wyckoff and Flushing Ave. A steam heating system will be installed in same. Total estimated cost, 120,000. H. J. Nurick, 957 Broadway, Eng.

N. Y., Brooklyn—The Weber Realty Co., 520 St. Mark's Ave., plans to construct a 1 story, 145 x 185 ft., theatre on St. Johns Pl., near Kingston Ave. A steam heating system will be installed in same. Work will be done by day labor. Total estimated cost, $230,000.

N. Y., Buffalo—W. F. McDonald, 577 Cambridge St., plans to erect a brick and concrete theatre on Hertel Ave., between North Park and Norwalk Ave. A steam heating and ventilating system will be installed in same. Total estimated cost, $220,000.

N. Y., Champlain—The Champlain Power Co. is repairing its plant and is in the market for new machinery.

N. Y., Geneva—Board of Public Works is in the market for a centrifugal pump, 4 million gallon per day capacity. J. W. Brennan, City Engr.

N. Y., Geneva—The O'Malley Motor Co. plans to build a 3 story, 50 x 100 ft. machine shop, garage and service station, on Canal and Exchange Sts., and will install transmission and electric power in same. Total estimated cost, $50,000.

N. Y., Long Island City—Louis Gold, 44 Court St., Brooklyn, will build a 5 story, 100 x 175 ft. garage on 7th and Pierce Ave. and a 1 story, 95 x 235 ft. factory, on Harris and Van Alst Ave. Steam heating systems will be installed in same. Total estimated cost, $220,000 and $150,000 respectively. Work will be done by day labor

N. Y., New York—Spec. No. 4016—The Bureau of Yards & Docks, Navy Department, Washington, D. C., plans to instal a turbo-air compressor, here. Estimated cost, $60,000.

N. Y., New York—The Department of Health plans to construct a 10 story, 100 x 100 ft. laboratory and office building at 136 West 30th St. A steam heating system will be installed in same. Total estimated cost, $700,000. R. S. Copeland, Supt. C. B. Myers, 1 Union Square, Arch.

N. Y., New York—The International Tailoring Co., 97 East Houston St., had preliminary plans prepared for a 12 story, 116 x 142 ft. office building on 4th Ave. and 12th St. A steam heating system will be installed in same. Total estimated cost, $750,000. Starrett & Van Vleck, 8 West 40th St., Engr.

N. Y., New York—The Krim Realty Co., 426 West 14th St., plans to construct a 3 story, 25 x 100 ft. store and office building at 143 West 33rd St. A steam heating sytem will be installed in same. Total estimated cost, $100,000.

N. Y., New York—The Port Morris Holding Co., c/o Winter & Co., 137th St. and Southern Boulevard, is having plans prepared for the construction of a 6 story, 375 x 382 x 316 x 390 ft. piano factory, on 141st St. and Walton Ave. A steam heating system will be installed in same. Total estimated cost, $500,000. Ballinger & Perrott, 47 West 34th St., Engr.

N. Y., New York—N. Reinhardt, 972 Brook Ave., Bronx, will receive bids until September 1st for the construction of a 6 story, 100 x 120 ft. ice plant on Bedford Park Blvd. Estimated cost, $150,000. M. Haulse, 3307 3rd Ave., Engr.

N. Y., New York—The 60 West 68th St. Corporation, Inc., 300 8th Ave., will build an 11 story, 80 x 85 ft. hotel, at 60-66 West 68th St. A steam heating system will be installed in same. Work will be done by day labor. Total estimated cost, $450,000.

N. Y., New York—Starrett & Van Vleck, Arch., 8 West 40th St., preparing plans for a 15 story, 80 x 115 ft. hotel to be erected on 72nd St. and West End Ave. A steam heating system will be installed in same. Total estimated cost, $1,000,000. Owner's name withheld.

N. Y., New York—The 305 West End Corporation, 200 West 72nd St., is having plans prepared for a 14 story, 100 x 143 ft. hotel, at 301-303 West End Ave. A steam heating system will be installed in same. Total estimated cost, $400,000. Schwartz & Gross, 347 5th Ave., Arch.

N. Y., New York—The 30 West 59th St. Incorporation, 120 Broadway, is having plans prepared for a 14 story, 50 x 80 ft. hotel, at 30 West 59th St. A steam heating system will be installed in same. Total estimated cost, $450,000. J. E. R. Carpenter, 681 5th Ave., Engr.

N. Y., New York—Warren & Wetmore, Arch., 16 East 47th St., will soon award the contract for the construction of a 180 x 200 ft. hotel, on Park Ave. and 51st St., for D. M. Linard, c/o architect. A steam heating system will be installed in same. Total estimated cost, $7,500,000. H. Balcom, 10 East 47th St., Engr.

N. Y., Norfolk—The Remington Paper and Power Co., Sherman Bldg., Watertown, plans to replace steam engine and transmission destroyed by bursting 14 ft. flywheel. Estimated cost, $20,000.

N. Y., Norwich—The city is having plans prepared for the construction of a library. A steam heating system will be installed in same. Total estimated cost, $125,000. Tooker & Marsh, 101 Park Ave., New York City, Engr. and Arch.

N. Y., Portchester—The Mint Products Co., c/o Lockwood, Greene & Co., Arch., 101 Park Ave., New York City, plans to construct a 4 story, 80 x 200 ft. factory. A steam heating system will be installed in same. Total estimated cost, $250,000.

N. Y., Poughkeepsie—Otto Wolpert, Arch. and Engr., 63 Park Row, will soon award the contract for the construction of a 1 story, 80 x 140 ft. threading machine factory on Fulton St. A steam heating system will be installed in same. Total estimated cost, $500,000. Owner's name withheld.

N. Y., Syracuse—The Great Northern Warehouse, Inc., plans to construct a 7 story, 150 x 200 ft. warehouse on West Fayette St. A steam heating system will be installed in same. Total estimated cost, $400,000. Thompson & Binger, Gurney Bldg., Engr.

N. Y., Syracuse—The H. H. Franklin Co., 302 South Geddes St., will install a steam heating system, two 600 h.p. boilers and automatic stokers in its new 60 x 140 ft. factory. Total estimated cost, $250,000. S. Firestone, Granite Bldg., Rochester, Engr.

N. Y., Taleville—The St. Lawrence Transmission Co., Massena, F. A. Stoughton, Pres., has purchased the rights of A. J. McDonald in the Freeman Talc Mine, near here, and plans extensive improvements and installation of crushing and conveying machinery and electrical driven units. Estimated cost, between $50,000 and $60,000.

N. Y., Waterloo—The Waterloo Wagon Co. plans to install machine tools, electric power drive and transmission. Estimated cost, between $12,000 and $15,000.

N. J., Bayonne—The Board of Directors of Bayonne City Hospital plans to build an addition to hospital, and erect a power plant and nurses' home. Total estimated cost, $250,000. Randolph Sluter, 79 West 41st St. and J. H. Mahken, 229 Broadway, are members of committee.

N. J., North Bergen—J. A. Migel, Inc., 442 4th Ave., New York City, will soon award contract for the construction of a mill, on Hudson Boulevard, here. A steam heating system will be installed in same. Total estimated cost, $500,000. Seabury-Dwight, 12 East Ave., Pawtucket, R. I., Engr. and Arch.

Penn., Carlisle—C. H. Masland & Sons, Inc., Amber and Westmoreland St., Philadelphia, is in the market for engines, piping and boilers for new power house which is to be built here in connection with mill. J. S. Rogers Co., Drexel Bldg., Philadelphia, Arch.

Penn., Hazelton—The Board of Education will soon award the contract for the construction of a 2 story, 60 x 300 ft. high school on Church St. A steam heating system will be installed in same. Total estimated cost, $250,000. D. A. Harmon, Hazleton, Arch.

Penn., McKeesport, Cristy Park—The National Tube Co., Frick Bldg., is receiving bids for constructing a 3 story, 46 x 90 ft. office building and a 3 story 47 x 64 ft. time building. Steam heating system reduction from high to low pressure, will be installed in same. Edward Stotz, Monongahela Bank Bldg., Arch.

Penn., Philadelphia—The Bureau of Water Supply, 792 City Hall, will receive bids until September 2 for 4 turbo-centrifugal pumps for the Queen Lane section.

Penn., Philadelphia—The Children's Hospital, 18th and Bainbridge St., plans to install a new power plant and boilers in the proposed addition. Address A. Harrison, Ch. Engr.

Penn., Philadelphia — The Comery Schwartz Motor Car Co., 128 North Broad St., plans to construct a 6 story, 210 x 440 ft. building at 24 Market St. A steam heating system will be installed in same. C. E. Oelschlager, 1615 Walnut St., Arch.

Penn., Philadelphia—The Department of Health & Charities plans to alter and enlarge, also construct new buildings at the Philadelphia Hospital for Contagiuos Diseases. A steam heating system will be installed in same. Total estimated cost, $300,000. Philip H. Johnson, 1713 Sansom St., Engr.

Penn., Philadelphia—The Methodist Episcopal Hospital, Broad and Wolf St., has had plans prepared for a 5 story, 80 x 125 ft. hospital on Broad and Ritner St. A steam heating system will be installed in same. Horace W. Castor, 21 South 12th St., Arch.

Penn., Pittsburgh—The Board of Education plans to construct a 4 story addition to South Hills High School, on Ruth St. A steam heating system, ventilating fan and low pressure boilers will be installed in same. Total estimated cost, $911,200. Alden & Harlow, Farmers' Bank Bldg., Arch.

Penn., West Bethlehem—The Board of Education will soon award the contract for the construction of a 2 story, 176 x 185 ft. school building. A steam heating system will be installed in same. Total estimated cost, $200,000. Ritter & Shay, North American Bldg., Philadelphia, Arch.

Penn., Wilkes-Barre—The city plans to build a 3 story, 63 x 276 ft. high school, with 75 x 75 ft. wing, on Grant and Sherman St. A steam heating system will be installed in same. Total estimated cost, $400,000. Robert Ireland, North Washington St., Engr.

Md., Baltimore—The Century Theatre Co., Inc., c/o C. E. Whitehurst, pres., Park Ave. and Lexington St., plans to construct a 2 story, 120 x 178 ft. theatre at 18 West Lexington St. Steam heating, electric lighting, air cooling and refrigerating systems will be installed in same. Total estimated cost, $750,000. J. J. Ziuk, 213 West Calvert St., Arch.

Md., Baltimore—F. A. Furst, Pres., Furst-Clark Construction Co., 1515 Fidelity Bldg., and other capitalists and financiers plan to build heating plant and substation in connection with development of 200 acre tract, from Spring Gardens to Fort McHenry Baltimore Southwest Channel Harbor, for system of docks and warehouses. Estimated cost, $175,000. F. W. Kesselbaum. c/o Baltimore Dry Dock & Ship Building Co., Locust Point, Engr.

Md., Baltimore—Hutzler Bros. Co., 212 North Howard St., plans to build an 8-story, 60 x 154x 60 ft. warehouse at Saratoga and State Sts. A steam heating system will be installed in same. Total estimated cost, $85,000. Frank Baldwin, 328 North Charles St., Arch.

Va., Ivor—The Ivor Light and Power Co., recently incorporated, plans to equip a plant for furnishing light and power in town and vicinity. T. A. Saunders, Pres.

Ohio, Cleveland—Allen Bros., Toronto, Canada, c/o A. M. Allen Co., Arch., 1900 Euclid Ave., are having plans prepared for a 10 story, 150 x 225 ft. theatre and commercial building to be erected on East 14th St. and Euclid Ave. A steam heating system will be installed in same. Total estimated cost, $175,000.

Ohio, Cleveland—The Board of Education, East 6th St. and Rockwell Ave., is having preliminary plans prepared for the construction of a 2 story, 80 x 120 ft. high school addition on East 55th St. and Scoville Ave. A steam heating sytem will be installed in same. Total estimated cost, $150,000. W. R. McCormack, East 6th St. and Rockwell Ave., Arch.

Ohio, Cleveland—The Brown Fence & Wire Co., 6532 Juanita Ave., plans to construct a 3 story, 100 x 180 ft. warehouse. A steam heating system will be installed in same. Total estimated cost, $125,000.

Ohio, Cleveland—The Chandler Motor Car Co., East 131st St. and St. Clair Ave., plans to build a 5 story, 42 x 95 ft. office building on East 131st St. and St. Clair Ave. A steam heating system will be installed in same. Total estimated cost, $100,000.

Ohio, Cleveland—The Colburn Machine Tool Co., 1041 Ivanhoe Rd., plans to build a 1 story, 192 x 238 ft. factory at 1040 Ivanhoe Rd. A steam heating system will be installed in same. Total estimated cost, $100,000.

Ohio, Cleveland—The Corday & Gross Co., 113 St. Clair Ave., plans to construct a 2 story, 135 x 200 ft. factory and print shop on East 24th St. and Chester Ave. A steam heating system will be installed in same. Total estimated cost, $300,000.

Ohio, Cleveland—The Crown Land Co., East 22nd St. and Superior Ave., plans to build a 6 story, 107 x 125 ft. factory, on West 3rd St. and Lakeside Ave. A steam heating system will be installed in same. Total estimated cost, $200,000.

Ohio, Cleveland—The Eveland Theatre Co., Hippodrome Bldg., plans to build a 10 story, 150 x 200 ft. theatre and office building, on East 7th St. and Prospect Ave. A steam heating system will be installed in same. Total estimated cost, $1,500,000.

Ohio, Cleveland—Joseph Laronge, 214 Williamson Bldg., plans to build a 10 story, 160 x 188 ft. theatre and office building on East 14th St. and Euclid Ave. A steam heating system will be installed in same. Total estimated cost, $3,000,000. T. W. Lamb, 644 8th Ave., New York City, Arch.

Ohio, Cleveland—Joseph Laronge, 214 Williamson Bldg., plans to erect a 6 story, 80 x 140 ft., commercial building on East 55th St. and Euclid Ave. A steam heating system will be installed in same. Total estimated cost, $150,000.

Ohio, Cleveland—The National Lamp Works, Nela Park, plan to build a 2 story, 64 x 139 ft. service building at Nela Park. A steam heating system will be installed in same. Total estimated cost, $150,000. Frank E. Willis, 56 West 45th St., New York City, Engr.

Ohio, Cleveland—The W. M. Pattison Co., 777 Rockwell Ave., is having plans prepared for a 4 story, 161 x 192 ft. addition to its factory, at 9205 Detroit Ave. A steam heating system will be installed in same. Total estimated cost, $100,000. The Osborn Engineering Co., 2848 Prospect Ave., Engr.

Ohio, Cleveland—Louis A. Skeel, 1040 Forest Cliff Drive, plans to construct a 5 story, 50 x 189 ft., commercial building at 2044 Euclid Ave. A steam heating system will be installed in same. Total estimated cost, $100,000.

Ohio, Cleveland—Schwartz, Forney & Hexter Co., West 6th & Lakeside Ave. plans to build a 5 story, 100 x 150 ft. factory, on East 30th St. and Superior Ave. A steam heating system will be installed in same. Total estimated cost, $250,000.

Ohio, Columbus—The Children's Hospital Association, Fair Ave. and Franklin Park West, plans to construct a 4 story, 40 x 200 ft. hospital with two wings, one 40 x 150 ft. and the other 25 x 60 ft., on 17th St. A steam heating sytem will be installed in same. Total estimated cost, $300,000. Richards, McCarty & Bulford, 584 East Broad St., Arch.

Ohio, Cleveland—The Vichek Tool Co., Mount Auburn St., is having plans prepared for a 1 story, 96 x 256 ft. factory addition, at 871 Mount Auburn St. A steam heating system will be installed in same. Total estimated cost, $100,000. G. S. Rider Co., Century Bldg., Arch.

Ohio, Dayton—The Gem City Ice Cream Co., 1005 West 3rd St., plans to enlarge its plant, and will install a 180-ton Hardwick ice machine and new electrical motors.

Ohio, Dayton—The National Military Home will soon award contract for the furnishing of one duplex Smith-Vaile pump, 5,000,000 gallon, 24" x 36" x 18"; two 125 h.p. R. T. Brownell boilers; three 100 h.p. open heaters; valves, piston rods, water plunger, etc. J. E. Gimperling, Quartermaster.

Mich., Detroit—The Board of Education, 50 Broadway Ave., is having tentative plans prepared for a high school, junior high school and elementary school, on Linwood, Webb and Collingwood Ave. Combined system or plenum system of heating will be installed. Total estimated cost, $1,000,000. Malcolmson & Higginbotham, 404 Moffat Bldg., Arch.

Mich., Detroit—The Board of Education, 50 Broadway, will soon award the contract for the construction of G. M. Condon School, on Buchanan and Vinewood Ave., 2 story, 110 x 130 ft., and the Nichols School, on Burns and Goethe Ave., 2 story, 78 x 105 ft. Separate boiler and fuel room, including boiler, fan, plenum heating system, etc., will be installed in same.

Mich., Detroit—C. W. Brandt, Arch., 1114 Kresge Bldg., plans to build a 2 story, 100 x 160 ft. theatre on Woodward Ave. A steam heating plant, boiler, fans and air washer, will be installed in same. Total estimated cost, $150,000. Owner's name withheld.

Mich., Detroit—D. L. Calwell, 701 Old Whitney Bldg., is having plans prepared for the construction of a 3 story, 150 x 160 ft. mercantile building, on Grand River Ave., near Hobson St. A steam heating system will be installed in same. Total estimated cost, $100,000. Williams Bros., 1111 Kresge Bldg., Arch.

Mich., Detroit—The City Water Commission, 232 Jefferson Ave., received bids for the construction of roof trusses and roof complete over engine room and pumping statin, building 67 x 307 ft., span of trusses 67 ft. from The Wisconsin Bridge and Iron Co., 1362 Penobscot Bldg., $62,000; Culbertson & Kelly, 814 Ford Bldg., $70,997, and Whitehead & Kales, Beecher St. and Michigan Central Ry., $84,365.

Mich., Detroit—Robert Finn, Arch., 435 Woodward Ave., is preparing plans for the construction of a 3 story, 70 x 110 ft. factory, on Riopelle and Winder St. A steam heating equipment, consisting of boiler and accessories, also motors for power, will be installed in same. Total estimated cost, $35,000. Owner's name withheld.

Mich., Detroit—Mildner & Eisen, 924 Hammond Bldg., Archs., are receiving bids for the building of a 2 story 75 x 130 ft. machine shop and office on Fourth and Porter St., for the Mutual Electric & Machine Co., 232 Fort St. A steam heating system will be installed, power to be furnished by electric motors.

Mich., Detroit—C. E. Rogers, 3 Goldsmith St., is having plans prepared for a 1 story, 100 x 214 ft. factory, on West Fort St. A steam heating system and electric motors for power will be installed in same. Total estimated cost, $80,000. Varney & Varney, 307 Palmer Bldg., Arch.

Mich., Detroit—The Westminster Presbyterian Church, Woodward and Parsons St., plans to build a 2 story, 114 x 118 ft. community house at Glynn Court and Hamilton Boulevard. A steam heating plant, consisting of boiler and accessories, will be installed in same. Total estimated cost, $100,000. G. M. Lindsey, 2201 Dime Bank Bldg., Arch.

Mich., Flint—The Flint Regent Theatre Co., Saginaw St., is receiving bids for a 1 story, 50 x 90 ft. theatre at Louisa and Saginaw St. A steam heating system will be installed in same. Total estimated cost $100,000.

Mich., Grand Rapids—St. Joseph Seminary, Boston St., is having plans prepared for the construction of a 3 story, 90 x 200 ft. seminary on Boston St. and Union Ave. A steam boiler, pump and accessories, will be installed in same. Total estimated cost, $200,000. Spier & Gehrke, 1317 Chamber of Commerce Bldg., Detroit, Arch.

Mich., Three Rivers—The Eddy Paper Co. has had plans prepared for the construction of a 50 x 100 ft. power plant on Michigan St. Five 300 h.p. vertical Wicks water tube boilers will be installed in same. Billingham & Cobb, Kalamazoo, Arch.

Mich., Wyandotte—Wyandotte Lodge, F. & A. M., is having plans prepared for a 3 story, 75 x 120 ft., Masonic Temple on Biddle Ave. A steam heating sytem will be installed in same. Total estimated cost, $115,000. G. W. Graves, 43 John R. St., Detroit, Arch.

Ill., Chicago—G. J. Breinig, of Rockford, c/o Henry J. Schlacks, Arch., 721 North Michigan Ave., is having plans prepared for a 2 story, 140 x 200 ft. dance hall to be erected on Grace St. near Broadway. A steam heating system will be installed in same. Total estimated cost, $150,000.

Ill., Chicago—The H. Channon Co., 150 North Market St., is having plans prepared for a 7 story, 120 x 180 ft. warehouse, on Randolph and Market St. A steam heating system will be installed in same. Total estimated cost, $400,000. Alfred S. Alschuler, 28 East Jackson St., Arch.

Ill., Chicago—The Fulton Market Cold Storage Co., c/o Gardner & Lindberg, Engr., 38 South Dearborn St., has had plans prepared and will soon receive bids for a 10 story, cold storage warehouse, on Fulton and Morgan St. Total estimated cost, $4,000,000.

Ill., Chicago—Z. E. Smith, Arch., 5501 Prairie Ave., will soon award the contract for a 4 story, 60 x 125 ft. factory and office building, on State St. and 36th Pl., for the Overton Hygienic Mfg. Co., 5200 South Wabash Ave. A steam heating system will be installed in same. Total estimated cost, $125,000.

Ill., Chicago—The Sheridan-Wilson Hotel Co., c/o W. W. Ahlschlager, Arch., 111 West Washington St., is having plans prepared for a 12 story, 130 x 225 ft. hotel on Sheridan Road and Wilson Ave. A steam heating system will be installed in same. Total estimated cost, $2,000,000.

Ill., Chicago—The Wilson-Jones Loose Leaf Co., 3021 Carrol Ave., plans to build a 2 story, 250 x 400 ft. factory, on Ohio St. and Spaulding Ave., to include power plant and garage. Total estimated cost, $100,000.

Wis., Janesville—The Bower City Bank, Main and East Milwaukee St., is having plans prepared by Childs & Smith, Arch., 64 East Van Buren St., Chicago, for the construction of a 6 story, 50 x 125 ft. bank and office building. A steam heating system will be installed in same. Total estimated cost, $200,000.

Wis., Peshtigo—The Peshtigo Paper Co. is receiving bids for furnishing motors and two 75 h.p. variable speed engines, etc. L. A. DeGuerre, Grand Rapids, Mich., Engr. Noted Aug. 5.

Wis., Superior—The city will receive bids September 11, for the building of a 3 story, 102 x 140 ft. auditorium, on Ogden Ave. and 14th St. Steam heating and ventilating systems will be installed. Total estimated cost, $150,000. J. O. Bach, 1111 Tower Ave., Engr.

Iowa, Davenport—Henry C. Kahl, c/o Walsh-Kahl Construction Co., is having plans prepared for the construction of a 10 story, 145 x 150 ft. theatre and office building on 3rd and Ripley Sts. A steam heating system will be installed in same. Total estimated cost, $1,000,000.

Ia., Dexter—The Town Council will soon receive bids for one 15 h.p. oil engine or motor, one 200 gal. per minute pump and one 12 x 16 ft. brick pump house in connection with its water distributing system.

Ia., Spencer—E. C. Tangney, Sheldon, is having plans prepared for a 4 story hotel here. A steam heating system will be installed in same. Total estimated cost, $100,000. Boyd & Moore, 314 Securities Bldg., Des Moines, Arch.

Iowa, Winterset—Board of Education will build a 2 story, 90 x 140 ft. school. A steam heating system will be installed in same. Total esitmated cost, $150,000. W. E. Hulse & Co., Hutchinson, Kan., Arch.

Minn., Alexandria—The county commissioners of Douglas County are in the market for 1 grain loading apparatus with bin, and one 8 to 12 h.p. engine. Vernon Thomas, County Auditor.

Minn., Chisholm—Town will build a 2 story, 100 x 175 ft. recreation building on Main St. A steam heating and mechanical ventilating system will be installed in same. Total estimated cost, $200,000.

Minn., Hastings—The State Board of Control, St. Paul, will receive bids until September 1 for the construction of a 1 story, 45 x 140 ft. power plant, here. Total estimated cost, $125,000. O. H. Johnston, Capital Bank Bldg., St. Paul, Engr.

Minn., Montevideo—W. E. Skinner, engr., received bids for extending waterworks system, including one 750 gal. per minute centrifugal pump with motor, switchboard and piping, etc., from W. D. Lovell, 2247 Hendon Ave., Minneapolis. $5621. Noted July 29.

Minn., St. Paul—The City Board of Water Commissioners plans improvements to cover a period of five years, to include conduit from Lake Vadnais to city, capacity 65,000,000 gals. each 24 hours, estimated cost, $440,000; low service main from Cayuga St. to congested district and new pumps, estimated cost, $300,000; impounding reservoir, 10,000,000,000 gals., estimated cost, $525,000; reservoir on Snelling Ave. near Otto St., $160,000.

Kan., Arkansas City—Arkansas Hotel Co. plans to construct a 3 story hotel. A steam heating system will be installed in same. Total estimated cost, $200,000. Shepard, Faurer & Wise, R. A. Long Bldg., Kansas City, Mo., Arch.

Kan., Arlington—The city voted $20,000 bonds to build an electric transmission line.

Kan., Chanute—The city voted $250,000 bonds for the construction of an electric light plant.

Kan., Emporia—The Citizens' National Bank is having preliminary plans prepared for a 7 story, 62 x 130 ft. bank. A steam heating system will be installed in same. Total estimated cost, $350,000. Weary & Alford, 1907 South Michigan Ave., Chicago, Arch.

Kan., Holton—Jackson County will build a 3 story, 85 x 100 ft. court house. A steam heating system will be installed in same. Total estimated cost, $140,000. W. Wiliamson & Co., Topeka, Arch.

Kan., Independence—The Commercial National Bank is having plans prepared for a 6 story, 70 x 140 ft. bank and office building. A steam heating system will be installed in same. Total estimated cost, $150,000. G. T. Guernsey, Pres. Weary & Alford, 1907 South Michigan Ave., Chicago, Arch.

Kan., Lyndon—Osage County will receive bids Sept. 4 for the construction of a 3 story court house. A steam heating system will be installed in same. Total estimated cost, $200,000. W. E. Hulse & Co., Hutchison, Arch.

Kan., Partridge—The city voted $20,000 bonds to build an electric transmission line.

Kan., Peabody—The F. P. Steinhauer Association is having plans prepared for a 3 story, 50 x 140 ft. hotel, to be known as the Hotel Forrester. A steam heating system will be installed in same. Total estimated cost, $100,000. D. B. Foster and J. H. Felt & Co., 802 Grand Ave. Temple, Kansas City, Mo., Arch.

Kan., Wichita—The Board of Education will receive bids about Sept. 2 for the construction of Mark Twain School, 3 story. A steam heating system will be installed in same. Total estimated cost, $250,000. H. A. Noble, Kansas City, Mo., Engr.

Kan., Wichita—The State Savings & Mercantile Bank, 115 East Douglas Ave., is having plans prepared for the construction of a 4 story, 55 x 140 ft. bank. A steam heating system will be installed in same. Total estimated cost, $150,000. Childs & Smith, 64 East Van Buren Ave., Chicago, Ill., Arch.

Neb., Blue Springs—The Board of Education is receiving bids for the construction of a 3 story, 100 x 140 ft. school. A steam heating system will be installed in same. Total estimated cost, $150,000. W. E. Hulse & Co., Hutchinson, Kan., Arch.

Neb., Lincoln—The Board of Education is having preliminary plans prepared for the construction of a 2 story school on 22nd and Lake Sts. A steam heating system will be installed in same. Total estimated cost, $450,000. Fiske & Meginnis, 533 Bankers Life Bldg., Arch.

Neb., Mead—The Board of Education c/o Fred Behrens, Chn., is having plans prepared for the construction of a 2 story, 80 x 130 ft. school. A steam heating system will be installed in same. Total estimated cost, $130,000. Ellery Davis, 1809 South St., Lincoln, Arch.

Neb., Omaha—M. E. Smith & Co., Kennedy Bldg., plans to build an 8 story, 100 x 132 ft. factory on 10th and Douglas Sts. A steam heating system will be installed in same. Total estimated cost, between $350,000 and $400,000. F. S. Scott, Kennedy Bldg., Arch.

Neb., Winnebago—Board of Education, Sioux Falls, S. D., will soon award the contract for the construction of a 2 story, 65 x 130 ft., grade school. A steam heating system will be installed in same. Total estimated cost, $100,000. Holmes & Flinn, 8 South Dearborn St., Chicago, Ill., Arch.

S. D., Bruce—The city will receive bids Sept. 5 for a 1750 hp. motor and a motor driven pump, 350 gal. per minute. L. P. Wolff, Guardian Life Bldg., St. Paul, Minn., Engr.

N. D., Maddock—The city will soon award the contract for the installation of an electric unit, including engine, generator, switchboard and necessary appurtenances.

Mo., Maryville—The city will receive bids Sept. 2 for the construction of two reservoirs, coagulatory plant, storage basin, two 600 g.p.m. motor driven pumps and one 7000 g.p.m. low service pump. Estimated cost, $35,000. E. E. Harper, 2408 East 30th St., Kansas City, Engr.

Okla., Okmulgee—L. H. D. Cook will receive bids Sept. 2 for the construction of a 2 story, 50 x 140 ft. theatre. A steam heating system will be installed in same. Total estimated cost, $100,000. Smith Rea, Lovitt & Senter, Okmulgee, Arch.

Cal., Los Angeles—The Board of Public Works will receive bids until Sept. 2 for furnishing sewage pumping equipment for the Manchester Ave. sewage pumping plant. Estimated cost, $6000. A. C. Hansen, City Engr.

N. S., Berwick—The Water Commissioners will receive bids until Aug. 30 for the construction of a concrete and timber dam, power house and wheel pit, including 1 15-in. diameter water turbine under 80 in. head. Total estimated cost, $27,500. S. E. March, Berwick, Engr.

CONTRACTS AWARDED

Mass., Pittsfield—The Common Council has awarded the contract for the construction of a 10 story schoolhouse, near present Pontassic school, to the Ernest & Carlson Co., 310 Main St., Springfield. A heating and ventilating system will be installed in same. Total estimated cost, $170,000.

R. I., Providence—The Rhode Island School of Design, Waterman St., has awarded the contract for the construction of a 4 story, 58 x 82 ft. jewelry building on Bene St., to C. B. Maguire Co., 1206 Turks Hero Bldg. A steam heating system will be installed in same. Total estimated cost, $125,000.

Conn., Danbury—The Standard Oil Co., Shelter Rock Rd., has awarded the contract for constructing 1 story pump house, 1 story, 11 x 45 ft. heater building and 1 story, 30 x 45 ft. garage, to the R. W. Smith Construction Co., 638 Lexington Ave. Total estimated cost, $22,000.

Conn., Forestville—The Peck & Young Manufacturing Co., Stratford Ave., has awarded the contract for the construction of a 1 story, 60 x 200 ft. factory, 1 story, 40 x 80 ft. garage and a 1 story, 25 x 35 boiler house, to the J. H. Grozier Co., 756 Main St., Hartford. Steam heating system will be installed in same. Total estimated cost, $50,000.

Conn., Hartford—The city has awarded the contract for the construction of a central heating plant, to take care of the public market and proposed new bath house, to the Ahern & Welch Co., 721 Main St. Estimated cost, $21,000. Noted May 13.

Conn., Hartford—The Hartford Times, 716 Main St., has awarded the contract for the construction of a 3 story office building on Prospect St., to Marc Eidlitz, 30 East 42nd St., New York City. A steam heating system will be installed in same. Total estimated cost, $100,000.

Conn., Plainville—Neri Brothers, 8 East Main St., has awarded the contract for the construction of a 3 story, 60 x 124 ft. brick business building on Main St., to Angelo Berti, 138 Oak St., New Britain. A steam heating apparatus will be installed in same. Total estimated cost, $100,000.

Conn., Waterbury—The Scoville Mfg. Co., 99 Mill St., has awarded the contract for the construction of a 4 story office building on Cole, Baldwin and Mills St., to Marc Eidlitz & Sons Co., 30 East 42nd St., New York City. A steam heating system will be installed in same. Total estimated cost, $150,000.

N. Y., Central Islip—The State Hospital Commission, Albany, has awarded the contract for installing new boilers, stokers, etc., in new central heating and lighting

plant for the state hospital here, to Chute, Thornton & Bayley Corporation, 2 East 13th St., New York City. Estimated cost, $81,600. Noted Feb. 4.

N. Y., Gouverneur—The Board of Education has awarded the contract for the installation of a new heating and ventilating system in the Gouveneur High School, to the Ryan Plumbing Co., Light & Power Bldg., Watertown. Estimated cost, $24,000. Noted July 22.

N. Y., Long Island City—The American Chicle Co., 19 West 44th St., New York City, has awarded the contract for constructing a 6 story, 200 x 600 ft. factory at Degnal Terminal, to the Turner Construction Co., 244 Madison Ave., New York City. A steam heating system will be installed in same. Total estimated cost, $2,000,000.

N. Y., Long Island City—L. J. Selznick, 729 7th Ave., New York City, has awarded the contract for the construction of a 200 x 600 ft. studio building on Van Alst, Ely and Moore St. and Queen's Boulevard, to the Fleischmann Construction Co., 531 7th Ave., New York City. A steam heating system will be installed in same. Total estimated cost, $1,500,000.

N. Y., New York—The Cunard Steamship Co., 24 State St., has awarded the contract for the construction of an office building at 29 Broadway, to Hines & Todd, 101 Park Ave. A steam heating system will be installed in same. Total estimated cost, $4,000,000.

N. Y., New York—The Seaboard National Bank, 18 Broadway, has awarded the contract for the construction of a 3 story, 80 x 94 ft. bank building, on Broad and Beaver St., to the C. T. Willis Construction Co., 286 5th Ave. A steam heating system will be installed in same. Total estimated cost, $350,000.

N. Y., New York—S. Straus & Co., 127 East 26th St., has awarded the contract for the construction of a 12 story, 25 x 100 ft. office building on 30th St. and Madison Ave., to the Continental Iron & Steel Co., 2 Rector St. A steam heating system will be installed in same. Total estimated cost, $140,000.

N. Y., New York—The 22 East 70th St. Corporation, 206 Broadway, has awarded the contract for the construction of a 13 story, 55 x 100 ft. hotel, at 850 Madison Ave., to Harvey, Abrams & Mellus, 15 East 40th St. A steam heating system will be installed in same. Total estimated cost, $500,000.

N. Y., New Rochelle—The Department of Education has awarded the contract for building a 3 story school, to Emil Dieditsch, 383 Madison Ave., New York City. A steam heating system will be installed in same. Total estimated cost, $200,000.

N. Y., Syracuse—The Merrill-Soule Co. has awarded the contract for the construction of a 5 story, 61 x 90 ft. cold storage building on North Franklin and Plum St., to the Turner Construction Co., 244 Madison Ave., New York City. Total estimated cost between $80,000 and $90,000.

N. Y., Syracuse—The University Methodist Church has awarded the contract for the construction of a 1 story, 63 x 112 ft. church on East Genessee St., to E. K. Fenno, 408 South Salina St. Present heating system will be enlarged. Total estimated cost, $175,000.

N. J., Plainfield—The Board of Education has awarded the contract for the construction of a 2½ story, 55 x 150 ft. school, to the Stewart-Willey Co., 1123 Broadway, New York City. A steam heating system will be installed in same. Total estimated cost, $140,000.

N. J., Verona—Essex County (Newark) has awarded the contract for heating and piping in the proposed 3 story sanatorium, at Orange Mountains, to Gillis & Geohegan, 537 Broadway, New York City. Estimated Cost, $59,500.

Penn., Philadelphia — The Philadelphia & Reading R.R., Reading Terminal, has awarded the contract for building a power house here, to R. E. Lamb, 841 North 19th St., Philadelphia. Noted June 17.

Md., Baltimore—A. W. Wilson Memorial Methodist Episcopal Church, 3013 Guilford Ave., has awarded the contract for the construction of a 1 story, 50 x 80 ft. church, on Charles St. and University Parkway, to D. M. Andrew Co., Mount Vernon and 26th St. Steam heating and electric lighting systems will be installed in same. J. W. Smith, pastor. Total estimated cost, $200,000.

N. C., Rutherfordton—The city has awarded the contract for furnishing and installing pumps in connection with waterworks system, to Gear & Wilson, Rutherfordton.

Ohio, Cleveland—The National Malleable Castings Co., 7706 Platt Ave., has awarded the contract for the construction of a 6 story, 50 x 208 ft. office building on Quincy and Woodhill Rd., to the Crowell-Lundoff Little Co., Meriam Bldg. A steam heating system will be installed in same. Total estimated cost, $300,000.

Ohio, Columbus—Timker Roller Bearing Co., Dueber Ave., Canton, has awarded the contract for the construction of a 282 x 482 ft. plant, to D. W. McGrath. Plans to include a 61 x 169 ft. carbonizing house, a 61 x 66 ft. boiler house and a 36 x 62 ft. storage house, on 5th and Cleveland Ave. Estimated cost, $550,000.

Mich., Detroit—Hugh Chalmers, 275 Iroquois Ave., has awarded the contract for the construction of a 2 story, 95 x 200 ft. hall and commercial building on Woodward Ave. and Watson St., including steam heating equipment, to F. H. Goddard, 516 Franklin St. Total estimated cost, $150,000.

Mich., Detroit—The Gordon, Pagel Co., 461 Chene St., has awarded the general contract for building a 2 story, 125 x 170 ft., addition to its bakery, on Hendricks and Duboise Sts., to G. D. Nutt, 632 Farwell Bldg., steel work, to The Russell Wheel & Foundry Co., Chene St. Electric power and steam heat from boilers will be installed in same.

Mich., Detroit—G. A. Lindke, Monroe and Farmer St., has awarded the contract for the construction of a 3 story, 140 x 159 ft. store and hotel, on Woodward Ave. and Peterboro St., to the Detroit Metal & Steel Co., 1st and Congress St. A steam heating system will be installed in same. Total estimated cost, $300,000. Rogers, Bonnah & Chaffee, 526 Farwell Bldg., Arch.

Mich., Detroit—The Packard Motor Car Co East Grand Boulevard, has awarded the contract for building a 4 story, 80 x 196 and 80 x 201 ft. service station, on Woodbridge and St. Antoine St., to the Bryant & Detwiler Co., 2336 Dime Bank. A vacuum steam heating system, vacuum pump and 2 boilers will be installed in same. Noted July 29.

Ill., Bement—The Board of Education has awarded the contract for building a 3 story, 50 x 200 ft. school, to English Bros., Champaign. A steam heating system will be installed in same. Total estimated cost, $125,000.

Wis., Kiel—The Kiel Woodenware Co. has awarded the contract for furnishing and installing 2 high pressure boilers, to the Freeman Manufacturing Co., Racine. Estimated cost, $10,500. Noted July 29.

Ia., Clarinda—The city has awarded the contract for 4½ million gallon pumps, 2 low duty and 2 high duty, in connection with the proposed waterworks system, to the American Well Works, 319 Reliance Bldg., Kansas City, Mo.

Minn., Duluth—The Marshall Wells Co., Lake Ave., S., has awarded the contract for the construction of a 4 story, 115 x 250 ft. addition to warehouse, to Jacobson Bros., 410 Columbia Bldg. Steam heating and mechanical ventilating systems will be installed in same. Total estimated cost $250,000.

Minn., St. Paul—The Northern Pacific Beneficial Association, 203 Railroad Bldg., has awarded the contract for the construction of a power house in connection with the proposed 3 story, 80 x 280 ft. hospital, on Snelling and University Ave., to J. and W. A. Elliott, 906 Lumber Exchange B'dg., Minneapolis. Total estimated cost, $500,000

Kan., Arkansas City—A. S. Newman has awarded the contract for the construction of a 5 story, 75 x 132 ft. hotel, to the Swenson Construction Co., 11th and Oak Sts., Kansas City, Mo. A steam heating system will be installed in same. Total estimated cost, $200,000.

Kan., St. John—The city has awarded the contract for building electric light plant and stack, also equipment, to the Merkle Machinery Co., Interstate Bldg., Kansas City, Mo. Equipment includes two 80 hp. boilers and 2 generators. Total estimated cost $47,800. Noted July 29.

Mo., St. Louis—The Arthur Realty Co., 6th St. and Washington Ave., has awarded the contract for the construction of an 11 story, 90 x 150 ft. store, on Washington Ave. and 6th St., to the Westlake Construction Co., 717 Locust St. A steam heating system will be installed in same. Total estimated cost, $480,000.

Col., Denver—The State Building Committee has awarded the contract for installing a steam heating system in the proposed 5 story, 112 x 114 ft. office building on the corner of Colfax Ave. and Sherman St., to McCarty & Johnson, 1418 Curtis St. Estimated cost, $13,306.

Wash., Olympia—The state has awarded the contract for installing heating system in the proposed new state buildings at Grand Mound to the Bergh-Griggs Co., Tacoma, at $11,705.

Cal., Los Banos—The Central California Creameries has awarded the contract for the construction of a 3 story, 150 x 150 ft. creamery, a 1 story power house and a 1 story warehouse, to Lange & Bergstrom, Sharon Bldg., San Francisco. Total estimated cost, $66,600.

Cal., Vallejo—Admiral Hotel Co., Inc., 808 Mechanical Institute Bldg., San Francisco, has awarded the contract for the construction of a 6 story, 80 x 130 ft. hotel here, on Virginia and Sonoma Sts., to McDonald & Kahn, Rialto Bldg., San Francisco. A steam heating system will be installed in same. Total estimated cost, $250,000.

N. B., St. John's—The Department of Public Works, Ottawa, Ont., has awarded the contract for the construction of a cofferdam, Courtenay Bay, at the entrance to dry dock, to the Bedford Construction Co., Halifax and St. John. Two 12 in. electrically driven water pumps will be installed in same.

Ont., Walkerville—The Motor Products Co., Walker Rd., has awarded the contract for the construction of a 2 story, 60 x 337 ft. factory addition, to the W. E. Wood Co., 1805 Ford Bldg., Detroit, Mich. Steam heating plant, 30" boiler, vacuum pump and receiver will be installed in same.

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